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THE BROWNIAN MOVEMENTS

By F. P. VENABLE

To come across detailed information with regard to certain facts which one has desired to locate for more than forty odd years has in it a thrill of pleasure and gratified curiosity. I have always wished to know something more as to the puzzling Brownian Movements since, as a student, I heard my first teacher in science, Prof. Mallet, of the University of Virginia, refer to them in his lectures. As I remember those lectures, he used these movements to illustrate and prove the unceasing motion which goes on between the molecules in all matter. I have often referred to them for the same purpose. Brown, however, is by no means an unusual name, and this Brown was unknown to me, and beyond the bare outline of one of his experiments I could find nothing concerning him or his work.

Prof. Lyman C. Newell has done a real service in placing on record an account of the life and work of this really eminent man, a more striking figure in botany than in any other science, and one who observed keenly, allowing no minutest, no apparently unimportant observation to escape him, investigating thoroughly and recording accurately both his investigations and conclusions.

Robert Brown was born in 1773. He studied medicine at Edinburgh University, receiving his degree and later entering the army as a surgeon. While at the University he was especially interested in botany. After a few years of service in the army he was engaged as naturalist in an expedition to carry out explorations in Australia, then an almost unknown country. So well was this work done that he was appointed librarian of the Linnean Society on his return. Later he became keeper of the Botanical Department of the British Museum and held this position until his death in 1858. He was a fellow of the Royal Society, was awarded the Copley medal, received the degree of D.C.L. from Oxford and that of LL.D. from Edinburgh. He was one of the five foreign associates of the Institute of France. All of these honors came

to him in recognition of his work and publications in the field of botany. His name was to live, however, and his fame rest on these obscure movements which perplexed him and so greatly excited his interest.

It is not surprising, then, that one might know something of him as a botanist and not identify him as the shrewd observer of the Brownian Movements. It was while engaged on a botanical investigation that these movements were observed. He published two articles in the Edinburgh *New Philosophical Journal*. The first article appeared in 1828 under the title "A Brief Account of Microscopical Observations made in the months of June, July, August, 1827, on the Particles contained in the Pollen of Plants, and on the General Existence of Active Molecules in Organic and Inorganic Bodies."

The second article was published in the Edinburgh *Journal of Science* in 1829, and consists of only five or six pages. Its title was "Additional Remarks on Active Molecules." The use of the term molecules instead of particles shows that Brown kept up with the advances in chemical theory, and observations of these movements today are useful in determining the size of molecules.

The apparatus available for his investigations was very limited, consisting of a double convex lens and a pocket microscope "with two lenses capable of delicate adjustment." The extracts given by Prof. Newell from these two articles make it possible to trace the progress of his investigations.

"The investigation of the unimpregnated ovulum led me to attend more minutely than I had done before to the structure of the pollen and to inquire into its mode of action. . . . It was not until late in the autumn of 1826 that I could attend to this subject. . . . Finding in one of the plants the figure of the particles contained in the pollen clearly discernible, and that figure not spherical but oblong, I expected with some confidence to meet with plants in other respects more favorable to the inquiry in which those particles from peculiarity of form, might be traced through their whole course. . . .

"The first plant examined was *Clarckia pulchella*. The grains of pollen taken from antheræ full grown but before bursting were filled with granules of unusually large size varying from 1-4000 to 1-5000 of an inch in length and of a figure between cylindrical and oblong, perhaps slightly flattened and having rounded and equal extremities. . . .

"While examining the form of these particles immersed in water I observed many of them very evidently in motion, their motion consisting not only of a change of place in this liquid manifested by alteration in

their respective positions but also not infrequently of a change of form in the particle itself. . . . These motions were such as to satisfy me, after frequently repeated observation that they were neither from currents in the fluid nor from its gradual evaporation but belonged to the particle itself.

"In extending my observations to many other plants of the same natural family similar motions of particles were ascertained to exist. I found also in the grains of pollen taken from certain plants immediately after bursting an increase in the number of particles.

"This great increase in the number of the particles before the grain of pollen could possibly have come in contact with the stigma was a perplexing circumstance in this stage of the inquiry and I accordingly examined numerous species of many of the more important and remarkable families of the two great divisions of phænogamous plants. In many plants belonging to several different families the membrane of the grain of pollen is so transparent that the motion of the larger particles within the entire grain was distinctly visible and it was manifest also at the more important angles and in some cases even in the body of the grain.

"Having found motion in the particles of the pollen of all living plants which I had examined I was next to inquire whether this property continued after the death of the plant and for what length of time it was retained. . . .

"Specimens of several plants, some of which had been dried and preserved in an herbarium for upwards of twenty years and others not less than a century, still exhibited the smaller particles in considerable numbers and in evident motion, along with a few of the larger particles whose motions were much less manifest and in some cases not observable."

Thinking that the motion might possibly be due to fertilization, and hence life-action, he extended his investigation to certain families of cryptogamous plants as mosses and Equiseta "in which the existence of sexual organs had not been universally admitted." With regard to these he states, "In the supposed stamina of both mosses and equiseta I found minute spherical particles having equally vivid motion on immersion in water, and this motion was still observable in specimens both of mosses and equiseta which had been dried upwards of one hundred years."

In his next step he obtained convincing proof that the vitality or Vital Forces theory had to be abandoned.

"The very unexpected fact of seeming vitality retained by these minute particles so long after the death of the plant would not perhaps have materially lessened my confidence in the supposed peculiarity. But I at the same time observed that on bruising the ovula or seeds of the Equiseta, which at first happened accidentally, I so greatly increased the number of moving particles that the source of the added quantity could no longer be doubted. I found also that on bruising the first floral leaves of mosses and then all other parts of these plants, I readily obtained similar particles not in equal quantity indeed but equally in motion."

It should be borne in mind that at the time Robert Brown was engaged upon this investigation the belief in the existence of a vital force was very generally held. It was assumed that such force was essential for the production of all compounds formed in life processes. It was in 1828, while Brown was still busy with the pollens, that Wöhler synthesized urea and thus did away with the supposed barrier between the mineral and plant and animal kingdoms. It was to this vital force that Brown first assigned the movements of his particles or molecules, as he called them. His first guess had to be abandoned, but he had the spirit of the true investigator and persisted in his efforts at finding the truth, the real cause of this persistent motion.

"Reflecting on all the facts with which I had now become acquainted I expected to find these molecules in all organic bodies and accordingly on examining the various animal and vegetable tissues, whether living or dead, they were always found to exist and merely by bruising these substances in water I never failed to disengage the molecules in sufficient numbers to ascertain their apparent identity in size, form, and motion with the smaller particles of the grains of pollen." It is noteworthy that he makes use of the term molecules showing his acquaintance with the most recent developments of physics and chemistry. Avagadro's molecular theory dates back only about a dozen years from the time at which he was working.

In his next step he goes beyond the seed in which dormant life might be said to exist though some of the material already examined by him might well be considered dead. He examines pit coal and finds the particles in abundance. The soot so liberally deposited from the smoky atmosphere of London is proved to be "entirely composed of these particles." A piece of fossil wood was examined with similar results. From this he goes to "mineralized vegetable remains" using a "minute portion of silicified wood which exhibited the structure of the coniferæ."

This "was bruised and molecules in all respects like those so frequently mentioned were readily obtained from it. Hence I inferred that these particles were not limited to organic bodies nor even to their products."

Step by step he pushed his search from living to dead pollen, from life products to mineral, and so crossed the supposed boundary rendering impossible his first hypothesis that this phenomenon was an exhibition of vital force in any possible phase.

But his search is by no means over. The problem of the incessant movement of these particles must be solved. He turns now to the distinctly inorganic substances, examining a fragment of window glass, such minerals as were at hand, specimens of the "simple earths," and metals with many of their compounds. Rocks of all ages were used including "those in which organic remains have never been found." The possibility of a vital force as an activating agent must be definitely excluded. It would seem that he puts his question to the Egyptian Sphinx as he examines a fragment of this monument of mystery.

His list of the minerals, rocks aqueous and igneous, plumbago, nickel, arsenic, etc., is a long one. He sums it all up by stating that "in every mineral which I could reduce to a powder sufficiently fine to be temporarily suspended in water I found these particles more or less copiously."

In attempting a solution of the phenomenon he states his belief "that these motions of the particles neither arose from currents in the fluid containing them nor depended on the internal motion which may be supposed to accompany its evaporation." He gives as his summary that "extremely minute particles of solid matter whether obtained from organic or inorganic substances when suspended in pure water or in some other aqueous fluids exhibit motions for which I am unable to account. . . . That the smallest moving particles observed and which I have termed active molecules appear to be spherical or nearly so and to be between $\frac{1}{20000}$ to $\frac{1}{30000}$ of an inch in diameter, and that other particles of considerably greater and various size and either of similar or of very different figure also present analogous motions in like circumstances."

In his book on "The Brownian Movement and Molecular Reality," Jean Perrin, the well-known French chemist, discusses these movements. Dr. Newell closes his account with the sentence, "If we believe with Perrin and others in the reality of molecules and their continuous movements then the name of Robert Brown will be immortal." Nearly a century has passed since Robert Brown did his work and published the

result of his investigation. It would be difficult to find in the annals of science one that was carried out with greater persistence in the effort at finding the truth. It was a wearying task and was prolonged over several years; at that period most scientific workers were content with the finding of mere facts. Few busied themselves as Lavoisier and Dalton had done with the nature of matter and the laws that govern energy in its action on water. Here was one who sought with all his powers to learn the underlying cause of observed phenomena.

Perhaps the work of Robert Brown interested few of his contemporaries. With the passing of the years, however, and the growth in knowledge it acquired an increasing importance and was cited in standard works. This interest has greatly grown in recent years. Man has learned that important truths are often hid in little things which seemed insignificant or escaped notice in earlier years. Therein lies the great merit of Robert Brown's work. Nothing was too small or apparently insignificant for him to spend his time upon and give to it his best thought.

In these later years this classical investigation has attracted attention once more and many workers are engaged in following the lines it opened up. In the past sixteen years the abstractors for the American Chemical Society have reported about 150 investigations of the Brownian Movements. In addition several books have been published regarding its bearing on molecules and the theories concerning them.

A number of these articles deal with the theoretical side. Taking advantage of the greatly improved apparatus now available, more accurate measurements of the size of the particles have been made. Linear magnification now is possible above 2,000,000 as compared with the 30,000 to 40,000 used by Brown. An ultramicroscopic study of them has been made and the moving-picture camera has been put to use to record the movements and make accurate study of them possible. Another important step has been the calculation of the electronic charge.

A brief summary of the progress made and theoretical conclusions reached may be appropriate in concluding this article. In the first place, the movements of particles suspended in various media has been studied. Thus, the particles suspended in oil and other emulsions, colloidal solutions, and particles in gases have been examined.

If these particles are to be compared with molecules or regarded as such it is necessary to determine whether the movements obey the known laws for molecules in solutions, molecules in gases, and molecular masses in colloids. These matters have been carefully investigated by

a large number of observers. While there are some differences of opinion and certain variations found, due doubtless to some of the particles being much larger than others, it may be regarded as settled as is stated by Perrin, that the kinetic theory may be quantitatively applied in considering the Brownian Movements; also that they obey the laws for movements of solids in solution, that they agree with the formulas of Einstein and Langmuir for the motion of particles suspended in a gas and subjected to molecular bombardment. Both of these distinguished men of science have studied these movements.

To settle such questions as these required far more knowledge than man had achieved at the time Robert Brown did his work, but he furnished a basis of fact for that which in its inception was but a theory, namely, that the finer subdivisions of matter possessed, under all conditions, motion, regular and unceasing.

NOTES ON THE OPILIONES OF THE SOUTHEASTERN UNITED STATES WITH DESCRIPTIONS OF NEW SPECIES

By C. R. CROSBY and S. C. BISHOP

PLATES 1–3

In the autumn of 1923 the authors were fortunate enough to spend several weeks in the Blue Ridge Mountains of North Carolina collecting arachnids. This region of wonderful scenic beauty is an entomological paradise and especially rich in Harvestmen or Opiliones. Although it was late in the season and our time for collecting limited, we secured a number of new and interesting forms. Further collecting, especially in late summer when the greater number of Harvestmen are mature, will greatly extend the number of species and add to our knowledge of their distribution.

In this paper we present the results of our work and have included a report on some material which we collected in the Okefinokee Swamp in Georgia and elsewhere, in 1912. All the figures were drawn by Albert W. Force. The type specimens are in the Cornell University collection and the paratypes in the New York State Museum.

OPILIONES LANIATORES

Family PHALANGODIDAE

Genus PHALANGODES Tellkampf

This genus is here used in the sense given it by Roewer. (Arch. f. Natur. **67,** Abt. A. Heft. 3: 140. 1912.) In describing the palpus it is considered as extended straight out in front of the body and not in its normal bent position.

The following table is modified from Roewer to include the new species described below.

1. Tarsus of palpus armed on the inner and outer sides with two large spine-bearing tubercles 2

   Tarsus of palpus armed on the inner and outer sides with three large spine-bearing tubercles 6

2. Patella of palpus without spine-bearing tubercles; tibia armed on each side with two of these tubercles . . . . . *flavipes* Banks

   Patella of palpus with spine-bearing tubercles 3

3. Without eyes 4
With eyes 5

4. Legs long and slender. Femur of palpus cylindrical, unarmed dorsally; tibia armed with two outer and two inner spine-bearing tubercles . . . . *armata* Tellkampf

Legs relatively short and thick. Femur of palpus thick, curved, compressed, toothed dorsally; tibia with three outer and inner spine-bearing tubercles . . . . . *californica* Banks

5. Eye-tubercle conical. Femur of palpus roughened dorsally. Dorsum of abdomen without median hump . . . . . *spinturnix* n. sp.

Eye-tubercle rounded, over-hanging behind. Femur of palpus smooth dorsally. Dorsum of abdomen with a low median hump. . . *laciniosa* n. sp.

6. Tarsus of second leg with nine segments of which the last three are more closely united. 7

Tarsus of second leg with eleven to thirteen segments of which the last three are more closely united. . . . . *flavescens* Cope and its varieties

7. Second segment of chelicera of male armed in front with two large processes. Body coarsely granulate. . . . . *brunnea* Banks

Second segment of chelicera of male not so armed. Body very finely granulate, nearly smooth. . . . . *acanthina* n. sp.

Phalangodes brunnea Banks. Figs. 1 and 2.

North Carolina: Blowing Rock, Oct. 10 (sifting under laurel); Grandfather Mt., 4,000 ft., Oct. 12; Montreat, Oct. 16. Several specimens of both sexes.

Phalangodes laciniosa n. sp. Figs. 3 and 4.

MALE. Length, 3.1 mm. Body orange-yellow with a lighter area, including the eye-tubercle. Legs lighter than body. Whole dorsum coarsely granulate, the granulations arranged in more or less regular tranverse rows, the granules larger on the free abdominal segments. Back of the eye-tubercle there is a distinct transverse sinuate furrow. Back of this furrow there is in the median line a low rounded hump. Eye-tubercle broad, low and rounded above, gradually descending in front and rounded behind so that it overhangs the base. Eyes small and placed in the middle of the tubercle as seen from the side.

Whole ventral surface coarsely granulate; on the abdominal segments the granulations arranged in transverse rows. Legs finely granulate with a few large rounded tubercles. Tarsus of the first leg with 4 segments (the last two slightly more closely united); of the second, with seven (the last three more closely united); of the third with five and of the fourth with six segments (the last two more closely united).

Palpus a little longer than the body. Trochanter short, globular and armed with one rather small spine-bearing tubercle below. Femur straight below, compressed laterally and rather strongly arched above; armed mesally on the distal half with two large spine-bearing tubercles; ventrally on the basal half, with three large and one small one, laterally and dorsally unarmed. Patella a little shorter than the femur, somewhat constricted at base and widened distally, armed with spine-bearing tubercles as follows: two very large ones on the distal half mesally, one somewhat smaller ventrally, laterally and dorsally unarmed. Tibia a little longer than patella, flattened and armed with spine-bearing tubercles as follows: mesally with three large ones, ventro-laterally with two smaller ones, dorsally unarmed. Tarsus about two-thirds as long as tibia, flattened and bluntly pointed, armed on each side with two large spine-bearing tubercles and a few smaller spines. First segment of chelicera rather long, cylindrical, and tapering towards the base; second segment armed on the dorsal (front) surface with 5 or 6 low blunt tubercles bearing small spines. Movable finger armed with 9 or 10 very small blunt teeth forming a serrated ridge. Immovable finger armed with a ridge of 7 or 8 pointed teeth.

Holotype, male. Oteen, N. C. Oct. 17, 1923. Under log.
Georgia: Tallulah Falls, July 20, 1909, 1 ♀, J. C. Bradley, coll.
Alabama: Cohort, April 11, 1912, 1 ♂, H. H. Smith, coll.

Phalangodes spinturnix n. sp. Figs. 5 and 6.

FEMALE. Length, 2.4 mm. Body yellow, legs and palpi lighter. Whole dorsum distinctly granulate. Back of the eye-tubercle are two indistinct straight, parallel transverse furrows. Eye-tubercle a blunt cone, seen from the side, nearly perpendicular in front, tapering behind, as high as the distance between the eyes.

Under side of body uniform yellow. Whole surface granulate, more strongly so on the edges of the coxæ.

Legs finely granulate. Tarsus of the first leg with 4 segments; of the second leg with 6 segments (the last 3 more closely united); of the third leg with 5 (the last two more closely united); of the fourth with 6 (the last two more closely united). All metatarsi with a false articulation near the apex.

Palpus a little shorter than the body. The trochanter bears ventrally one small spine-bearing tubercle. Femur straight below and arched above, somewhat compressed laterally. On the dorsal surface are

numerous small tubercles, on the meso-ventral side on the distal half two large spine-bearing tubercles, on the ventral side an oblique row of 3 large and 1 small spine-bearing tubercles, the basal one the largest. Patella two-thirds as long as the femur, armed ventro-mesally with two large spine-bearing tubercles and ventrally with one. Tibia about as long as patella, with large spine-bearing tubercles as follows: on the mesal side a row of three (dorsad of which there is a row of small spines), and on the lateral surface two. Tarsus about half as long as the tibia, flattened and tapering to a blunt point, armed on each side with two large spine-bearing tubercles. Terminal claw nearly as long as tarsus. First segment of chelicera cylindrical, slightly constricted near base; second segment armed on dorsal (front) surface with 8 or 9 small tubercles bearing hairs. Immovable finger armed with 4 or 5 small blunt teeth, the movable finger with 5 or 6.

Holotype, female. Chastine, La., March 16, 1917. Under tie chip. K. P. Schmidt, coll.

Mississippi: Oxford. One immature, R. H. Fulton, coll.

Phalangodes acanthina n. sp. Figs. 7 and 8.

MALE. Length, 1.6 mm. Body yellow, finely mottled with reddish brown, the marking lighter at the sides of and behind the eye-tubercle. The hind margin of the dorsal plate and the free dorsal segments each marked by a transverse reddish brown band. Legs and palpi lighter than the body; the ground color straw-yellow; the degree of mottling varies considerably. Whole dorsal surface very finely granulate. Eye-tubercle conical and more strongly granulate; the eyes situated near the base and as far apart as the tubercle is high. Color of the underside of the body like the dorsum except that the coxæ and genital plate are less strongly mottled with reddish brown. Ventral abdominal segments banded with reddish brown as above. The ventral surface in general finely granulate; coxæ of second to fourth legs with a few small tubercles towards the tip. Legs finely granulate. Tarsus of the first leg with 4 segments; of the second with 9 (the last three more closely united); of the third and fourth with 4 each (the last two very closely united).

Palpus a little longer than body. Trochanter nearly cylindrical, sharply constricted at base. Femur straight ventrally, compressed laterally and strongly arched and swollen dorsally, armed dorsally with a row of 4 blunt tubercles increasing slightly in size towards the tip; on the mesal side there are near the tip two strong tubercles bearing

movable spines; on the ventro-mesal side there are 4 spine-bearing tubercles on the basal half, the first very long, and the other three short; the ventro-lateral side bears a row of 3 or 4 large spine-bearing tubercles, the first and second larger than the others. Patella about half as long as the femur, strongly arched dorsally, armed dorsally with 3 small short tubercles, one near the base and two near the apex; on the mesal side two very large tubercles with movable spines on the distal half; on the ventro-lateral side near the apex one similar but smaller tubercle with spine. Tibia about as long as femur, flattened ventro-dorsally, armed dorso-laterally with 4 small spiniferous tubercles, mesally with 4 very large tubercles with movable spines, the middle two twice as long as the others, armed ventro-laterally with three very large tubercles with spines, the middle one the longest. Tarsus about as long as tibia, flattened and tapering to a point; mesal margin with three very large and one small spine-bearing tubercle, the small one at the tip; lateral margin with 3 large and 1 small but similar tubercles, the small one at the base. Terminal claw two-thirds as long as the tarsus.

Chelicera with the first segment cylindrical, slightly constricted near base; second segment armed on dorsal (front) surface with 8 or 9 small tubercles. Immovable finger armed with 6 blunt teeth; movable finger with 5 teeth.

Female similar to male and about the same size. Palpus a little less robust than in male. Spines on the palpus arranged as in the male except on the femur. On this segment on the ventral side there is an oblique row of 4 spine-bearing tubercles, the distal one smaller than the others.

Holotype, male. 15 specimens of both sexes. Raleigh, N. C., Oct. 26, 1923. Collected by sifting decaying leaves under loblolly pine on the Walnut Creek bottoms.

District of Columbia: May 1, 1924, 12 specimens of both sexes.

Maryland: Cabin John, Dec. 3, 1918, 1 specimen; Rockville, May 29, 1924, 1 specimen.

This species can be distinguished from *brunnea* Banks by the form of the male chelicera, by its lighter color and by the shape of the eye tubercle and from *flavescens* Cope by the number of segments in the tarsus of the second leg (11–13 in that species).

OPILIONES PALPATORES

Family PHALANGIIDAE

Genus LEIOBUNUM C. Koch.

This genus is well represented in the southeastern United States. We have adopted the spelling used by C. Koch when he established the genus.

KEY TO THE MALES OF LEIOBUNUM BASED ON THE TABLE PUBLISHED BY BANKS (Am. Nat. 35:675. 1901)

1. Femur of palpus armed with a distinct spur . . . . . *calcar** Wood
   Femur of palpus not armed with a spur 2
2. Palpus, except tarsus, mostly black 3
   Palpus yellowish or brownish 4
3. Dorsum dark, often with two large pale spots behind; trochanters usually pale . . . . . *exilipes* Wood
   Dorsum pale yellowish, without stripe, trochanters and base of legs black *nigripalpi* Wood
4. Femur, patella, and tibia of palpus plainly incrassate, dorsum with a black stripe, trochanters black . . . . . *crassipalpis* Banks
   Palpal segments not incrassate 5
5. Femur of palpus long curved, extending much above surface of cephalothorax 6
   Femur of palpus shorter, straighter, not extending much above surface of cephalothorax 8
6. Body with a distinct dark median stripe . . . . . *vittatum* Say
   Body without a distinct dark median stripe 7
7. Legs black . . . . . *uxorium* n. sp.
   Legs mostly brown . . . . . *speciosum* Banks
8. Dorsum dark, with two large yellowish spots on union of cephalothorax and abdomen . . . . . *bimaculatum* Banks
   Not so marked 9
9. Apex of tibia II white, trochanters black, body short . . . . . *longipes* Weed
   Apex of tibia II not white 10
10. Apex of femur I white, preceded by a black band, coxæ pale outside . . *townsendi* Weed
    Femur I not so marked 11
11. Trochanters dark, contrasted in color with the coxæ 12
    Trochanters pale, concolorous with coxæ 15
12. Legs black, dorsum dark brown, eye-tubercles slightly spinulate . *nigripes* Weed
    Legs pale, sometimes marked with black 13
13. Femur I barely as long as body, tips of femora and tibia dark brown or black, eye-tubercle nearly smooth . . . . . *formosum* Wood

*L. *serratipalpe* Roewer is omitted because it is probably an immature form of *calcar*.

Femur I plainly longer than body, eye-tubercle spinulate, legs not so distinctly marked with black 14

14. Abdomen tapering behind, dorsum golden, base of femora not black, trochanters dark brown, of moderate size . . . . . *verrucosum* Wood

Abdomen rather short and broad, legs very long, small species . . *bicolor* Wood

15. Dorsum marked with four longitudinal light lines . . . . . *cretatum* n. sp.
Dorsum not so marked 16

16. Abdomen pointed posteriorly . . . . . *ventricosum* Wood
Abdomen bluntly rounded posteriorly 17

17. Body 5 mm. or less in length; hind femora usually black at base *politum* Weed
Body 6 mm. or more in length; base of femora not darkened 18

18. Abdomen strongly arched above, distinctly spinulose . . . . *aurugineum* n. sp.
Abdomen nearly flat above, granulate but not spinulose . . . . *flavum* Banks

Leiobunum aurugineum n. sp. Fig. 9.

MALE. Length, 6 mm., width, 3.5 mm. Integument coriaceous. Whole dorsum of body golden yellow, cephalothorax darker, mottled on the sides with lighter, two diverging yellow lines in front of eye-tubercle. The dorsal stripe not much darker than the rest of dorsum but fairly well outlined on the first three abdominal segments (in another specimen indistinctly evident to the tip of abdomen). Cephalothorax finely tuberculate; an area of larger tubercles in front of the eye-tubercle and along the front margin. Dorsum of abdomen more strongly tuberculate. Eye-tubercle golden yellow on the sides, a black spot above each eye, the canal light yellow; each carina armed with a row of 5 or 6 small blunt tubercles. Ventral surface lighter than above; coxæ and genital plate a little darker than abdomen. Coxæ armed with numerous small tubercles, the lateral rows of denticles strongly developed. Ventral abdominal segments armed with scattered minute piliferous tubercles.

Length of legs: first, 17 mm.; second, 39 mm.; third, 21 mm.; fourth, 31 mm.

Coxæ and trochanters concolorous, golden brown. Rest of legs brown, darker on the patella and tibia and lighter on the terminal segments.

Palpus golden yellow, tarsus lighter. Femur slender, almost straight below and slightly armed above, armed ventrally at base with a few stiff hairs and small denticles, ventro-mesally with stiff hairs and ventro-laterally with a patch of small black-tipped denticles and a few stiff hairs. Patella half as long as femur, strongly bent, armed except at base below with scattered small denticles and stiff hairs. Tibia a little longer

than patella, armed ventrally with a mixture of small denticles and stiff hairs. Tarsus slightly longer than femur, armed ventro-mesally with a single row of small denticles. Terminal tooth with a few small teeth near base.

FEMALE. Length, 8 mm. General coloration much as in the male but the dorsum more distinctly banded with brown on which the tubercles show as yellow dots. Median stripe sometimes fairly well outlined and sometimes almost obsolete. Body seen from the side very convex above, highest on the second abdominal segment. Viewed from above bluntly rounded, not pointed, behind.

Length of legs: first, 25 mm.; second, 45 mm.; third, 26 mm.; fourth, 36 mm.

Holotype, male. Type locality, Billy's Island, Okefinokee Swamp, Ga., June, 1912. 1 ♂ and 4 ♀.

Georgia: Mixon's Hammock, Okefinokee Swamp, June 16, 1912. 2 ♂.

Leiobunum speciosum Banks. Fig. 10.

MALE. Length, 4.5 mm. Dorsum of body golden yellow, the lateral margin of the cephalothorax and the two transverse ridges back of the eye-tubercles narrowly edged with black, rather coarsely granulate, rougher on the abdomen. The abdominal segments with a few small light yellow spots arranged in irregular transverse rows. Abdomen bluntly rounded behind. Eye-tubercle orange-brown, shallowly canaliculate, the carinæ armed with four or five small, blunt, black-tipped teeth; eye surrounded by a narrow dark brown ring. Ventral surface light yellowish, darker on the coxæ and lighter on the genital plate and posterior margin of the first and second abdominal segments; finely granulate on abdomen, coarser on genital plate and coxæ. Rows of denticles on the coxæ moderately developed.

Length of legs: first, 51 mm.; second, 75 mm.; third, 50 mm.; fourth, 70 mm. Trochanter and extreme base of femur very dark brown to black. Rest of legs light brown with the tip of femur, patella, base and tip of tibia, dark brown. Palpus light yellow, darker above on the basal half of femur. Femur long, slender and curved, of the general type of the femur of *vittatum* but relatively somewhat shorter, more slender and not so strongly curved, armed distally above with 4 or 5 small black-tipped denticles, ventro-laterally with a regular row of denticles and apically below with a group of 4 or 5 of them. Patella about half as long as the femur, armed ventro-laterally with a row of small denticles.

Tibia a little longer than the patella, armed ventro-laterally with a double row of denticles, ventro-mesally towards the tip with 2 or 3. Tarsus a little longer than the tibia, armed ventrally at the base with one small denticle and ventro-mesally with single row of strong black-tipped denticles. Claw armed with 7 or 8 teeth. Cheliceræ light yellow, a spinose hump on the second segment at the base of the immovable finger.

In a male from Tallulah Falls, Ga., the dorsum is lighter, on the cephalothorax in front of the eye-tubercle nearly white.

FEMALE. Length, 5 mm. Very similar to the male in coloration. Legs with the trochanters and extreme base of femora black, the rest brown, more uniform than in the male.

Length of legs: first, 51 mm.; second, 102 mm.; third, 49 mm.; fourth, 64 mm.

Femur of palpus shorter and less curved than in the male.

Georgia: Spring Creek, Decatur Co., July, 1912, 1 ♂ and 6 ♀; Tallulah Falls, July 27, 1909, 1 ♂, J. C. Bradley, coll.

Alabama: Holt, 1 ♂; Killen, Oct., 2 ♀, H. H. Smith, coll. 1 ♀, co-type of *L. speciosum* Banks, without locality but probably from near Auburn, Ala. (The form considered by him as the male).

Banks described what he thought were both sexes of this species from a few specimens from Alabama. Both forms were females; the one he considered as the female is a female of *L. bimaculatum*, of which we have a large series from the southern states, and the one he considered as the male is the female of *L. speciosum*. Roewer (Abhandl. a. d. Gebiete d. Naturw. 19:228, pl. 6, fig. 15. 1910), misled by specimens which he received from Banks, has described and figured the female of *L. bimaculatum* as the female of *L. speciosum*. See further under *L. bimaculatum*.

Leiobunum bimaculatum Banks. Figs. 11 and 12.

MALE. Length, 4 mm. Dorsal surface very dark reddish brown, nearly black. Dorsal stripe broad behind the eyes, narrower on the last thoracic segment and still narrower on the first abdominal segment; it widens on the second and then gradually narrows towards the tip. The stripe is more or less outlined in black. On the last two thoracic and first abdominal segments it is bordered on each side by a silvery white area which is often broken into 3 spots, the anterior one the smallest. In some specimens the white extends forward to the front margin of the cephalothorax. Dorsal surface minutely spinulose. Eye-tubercle brown above in the groove, black behind, and usually white or pale in front, shallowly canaliculate, each carina armed with three

rather large blunt tubercles. Under surface of body silvery white tinged with yellowish. The abdominal segments armed with transverse rows of short slender tubercles between which the integument is granulate. On the coxæ and genital plate the tubercles are not arranged in rows. Rows of denticles on coxæ rather strongly developed.

Tip of abdomen seen from above truncate, the last 3 segments turned under so as to be visible from below in many specimens.

Legs light brown, patellæ and tip of femora darker.

Length of legs: first, 40 mm.; second, 81 mm.; third, 41 mm.; fourth, 59 mm.

Palpus yellow. Femur straight and cylindrical, armed ventrally with a double row of small teeth. Patella short and strongly bent, armed dorsally and mesally with a few short, flattened, forward-directed spines. Tibia short, only a little longer than the patella and similarly armed. Tarsus long, slender, thickened at tip, without a row of denticles, a brush of brown hairs on the underside at base of claw.

FEMALE. Length, 7 mm.

Cephalothorax very dark brown crossed on each side by a longitudinal, interrupted silvery white or yellowish stripe. These two stripes are united back of the eye-tubercles by two narrow transverse bands. In front of the eye-tubercle are two slightly divergent light lines arising from the light-colored front of the tubercle. Dorsal stripe well defined on the abdomen, interrupted on the last three dorsal segments by cross bands of lighter brown continuous with the brown of the sides. The dorsal stripe is bordered on each side on the front of the abdomen with a large silvery yellow spot, back of this the border is golden brown. On the last three dorsal segments the stripe is bordered by golden spots. In different individuals there is considerable variation in color and in the distinctness of the markings. Under surface of body much as in male but has a more decided golden tinge.

Length of legs: first, 50 mm.; second, 75 mm.; third, 47 mm.; fourth, 60 mm.

Georgia: Bainbridge, Sept.–Oct., 1910, 4 ♀ and 3 ♂, J. C. Bradley, coll.; Billy's Island, Okefinokee Swamp, May and June, 1912, many specimens, 1 ♂, May 31, 1912, A. H. Wright, coll. (also taken at Mixon's Hammock and Honey Island in the Swamp); Dewitt, July 23, 1912, 2 ♀, M. D. Leonard, coll.; Thunderbolt, June 26, 1912, 2 ♂; Spring Creek, Decatur Co., Sept. 30, 1910, and July, 1912, several specimens; Waynesville, Sept. 10, 1907, 1 ♂, J. C. Bradley, coll.; Waycross, May 8, 1911, 1 ♂, J. C. Bradley, coll.; Stone Mt., Oct. 9, 1910, 1 ♀, J. C. Bradley, coll.; Tifton, Sept. 9, 1910, 4 ♀ and 5 ♂, J. C. Bradley, coll.

Mississippi: Ocean Springs, Jan., 1905, 5 ♂ and 2 ♀, J. H. Comstock, coll.
Florida: Long Boat Key, Sarasota, Aug. 14, 1910, 1 ♀.
Alabama: Tuskeegee, June 10, 1917, 1 ♀; University, July 21, 1911, 1 ♂.
1 ♂ lectotype. Without locality.
In the original description Banks gives the locality as southern California and says the specimen was loaned him by Dr. George Marx. One cannot help suspecting that there was a mistake in the locality.
1 ♀ labelled as co-type of *Leiobunum speciosum* Banks. This is the form which he described as the female of that species. No locality, but probably from near Auburn, Ala.

Leiobunum uxorium n. sp. Figs. 13 and 14.

MALE. Length, 4 mm. Dorsum of body finely granulate, orange-yellow, sometimes mottled indistinctly on the thorax with lighter. The median stripe sometimes very indistinct, in some specimens it surrounds the eye-tubercle with a triangular area and is faintly indicated on the abdomen. Abdominal sutures marked with rows of pale spots, on the sides of the first to third, and the whole width on the fourth suture. Abdomen rather bluntly rounded behind. Eye-tubercle very dark brown, lighter at base in front, shallowly canaliculate, with a row of 8 or 9 small blunt tubercles on each carina.

Underside of body lighter than above, yellowish suffused with dusky; very finely granulate on abdomen and genital plate, noticeably coarser on the coxæ. Coxæ with a row of minute denticles on anterior margin.

Legs very dark brown or black.

Length of legs: first, 43 mm.; second, 60 mm.; third, 43 mm.; fourth, 61 mm.

Palpus mottled orange-yellow, dorsum of femur, patella and tibia marked with transverse bands of lighter color. Trochanter armed dorsally with 3 or 4 very small tubercles; femur long and slightly curved, armed ventro-laterally and ventro-mesally with a scattered row of small denticles, armed dorsally near the tip with 3 or 4 small blunt tubercles; patella about half as long as femur, widened distally and armed with a few scattered denticles on the sides mostly confined to the basal half; tibia nearly cylindrical, a little longer than the patella, armed ventro-laterally on the basal half with a few small denticles and ventro-mesally on the distal half with a row of about 10 small black-tipped teeth; tarsus about as long as femur, slender, slightly swollen near tip, armed ventro-mesally with a single row of small black teeth.

FEMALE. Length, 7 mm. Dorsum of body mottled dark and light brown; the dorsal stripe outlined with black on the abdomen, interrupted

on the posterior segments. Eye-tubercle black. Coxæ grayish brown, ventral side of abdomen varies from dusky white to reddish brown, darker posteriorly. Trochanter, base of femur, tip of tibia, metatarsus and tarsus nearly black; rest of femur, patella, and all but tip of tibia, brown. Palpus mottled dark and light brown above, lighter below, tarsus dusky yellow.

Holotype, male, allotype, female, collected *in coitu*, Oteen, N. C., Oct. 20, 1923. Many other specimens collected at the same time. They were mating in considerable numbers on a sunny bank at the edge of a pine woods. Madison, Oct. 8, 1 ♂.

Virginia: Buchanan, Oct. 6, 1923, 1 ♂; Strasburg, Oct. 4, 1923, 1 ♂.

Georgia: Austell, Nov. 25, 1910, 3 ♂; Spring Creek, Decatur Co., Sept. 25 to Oct. 1, 1910, 5 ♂ and 5 ♀, J. C. Bradley, coll.

Pennsylvania: Gettysburg, Oct. 3, 1923, 1 ♂.

Leiobunum cretatum n. sp. Fig. 15.

Probably male. Length, 3.9 mm. Dorsal surface of body dark reddish brown, marked with five narrow longitudinal light lines as follows: a median line from back of eye-tubercle to tip of body; a line on each side running from midway between the eye-tubercle and the front margin diagonally to a point opposite the eye-tubercle, then backward to the second transverse suture, then diagonally toward the median line which it parallels to the tip of abdomen; the lateral lines start on the cephalothorax opposite the second coxæ and converge towards the tip of the body. Eye-tubercle moderately canaliculate, viewed from the side nearly vertical in front, somewhat overhanging behind, each carina armed with a row of 6 or 7 small tubercles; color dark brown; the carinæ, a spot under each eye, and the front of the tubercle, somewhat lighter. Dorsal surface coriaceous, rugose.

Ventral surface light yellowish, coxæ slightly darker. Abdominal segments each with a single row of small tubercles. Coxæ and genital plate irregularly finely tuberculate.

Legs with the coxæ and trochanters concolorous. Rest of legs yellowish, tip of femur, patella, base and tip of tibia, brown.

Length of legs: first, 31 mm.; second, 45 mm.; third, 31 mm.; fourth, 43 mm.

Palpus yellow. Femur slender, cylindrical, armed ventrally with a double row of well-separated sharp triangular teeth. Patella about half as long as femur, rather sharply bent at base and slightly widened and prolonged on the inner distal angle, armed dorsally with a few minute

flattened forward-directed teeth. Tibia a little longer than patella, nearly straight, armed ventrally with numerous minute flattened teeth. Tarsus longer than tibia and patella combined, slender, enlarged apically, armed dorsally with very minute flattened forward-directed teeth, visible only under high power. In two immature specimens the stripes on the body are much more distinct and the general coloration is lighter.

Type, probably male. Oglethorpe, Ga., July 1, 1910, J. C. Bradley. 2 immature, Unadilla, Ga., June 28, 1910, J. C. Bradley, coll.

Leiobunum flavum Banks

Banks described this species from two specimens, a male from Shreveport, La., and a female from Harper's Ferry, W. Va. An examination of the types convinces us that they represent two separate species. We would designate the male as the lectotype. The female seems to be a specimen of *L. ventricosum* Wood. After a careful examination of the types we are unable to convince ourselves of the presence of a transverse groove on the last ventral segment in either sex. Of the species as restricted above we have seen the following specimens:

Missouri: Columbia, June, 2 ♀ and 1 ♂.
Texas: Victoria, Aug., 1905, 1 ♀.
Louisiana: Chastine, May 12, 1915, 1 ♂, K. P. Schmidt, coll.
Kentucky: Bee Spring, 1 ♂ (determined by Banks).
1 ♂ lectotype in bottle with 1 ♀, labeled "Type" with locality label "Harper's Ferry, W. Va.," but from the statement in the original description evidently from Shreveport, La.

MALE. Length, 6.5 mm. Dorsum of body golden yellow armed with minute tubercles. Smooth impressed darker areas are placed as follows: Starting on each side of the eye-tubercle two broken lines curving inward and becoming parallel, fading out before reaching the front margin; back of the eye-tubercle a short transverse bar; back of the opening of the scent gland a curved bar; opposite the eye-tubercle on each side an irregular trilobed spot. On the front of the abdomen the central marking is indicated by two short parallel lines. Central marking outlined vaguely posteriorly. Eye-tubercle golden, shallowly canaliculate, each carina armed with 7 or 8 small teeth; eyes ringed with black.

Underside of body silvery yellowish, abdomen minutely tuberculate, genital plate and coxæ more coarsely tuberculate. Marginal denticles strongly developed.

Legs golden yellow without metallic luster, patellæ slightly darker. Coxæ slightly lighter than trochanters but not strongly contrasted. Palpus yellowish. Femur of palpus nearly straight, cylindrical; armed with small black-tipped pointed tubercles, more numerous distally above; patella about half as long as femur, strongly bent, enlarged distally and armed similarly; tibia a little longer than patella, cylindrical, with a smooth longitudinal area above; tarsus slender, about as long as femur, armed beneath with a single row of minute denticles.

FEMALE. Length, 7 mm. Same general color and armature as the male. In one specimen the central marking fairly well defined. Abdomen not quite so blunt behind as in the male but not pointed as in *L. ventricosum*.

Leiobunum longipes Weed

North Carolina: Grandfather Mt., Oct. 12, 2 ♀.
Georgia: Tallulah Falls, June 17, 1910, immature specimens.

Leiobunum nigripalpi Wood

Kentucky: Pine Mts., Bell Co., 2,200 feet, Aug. 12, 1919, 1 ♂, W. D. Funkhouser, coll.

Leiobunum politum Weed

Georgia: Athens, June 15, 1909, 1 specimen.

Genus HADROBUNUS Banks

Hadrobunus grande Say

Virginia: Richmond, Sept. 16, 1 specimen.

Hadrobunus maculosum Wood

Georgia: Dewitt, March, 1913, and April, 1912, 10 specimens, C. Spooner, coll.; Thomasville, March 1, 1915, 1 specimen, C. Spooner, coll.

Genus ODIELLUS Roewer

Odiellus nubivagus n. sp. Figs. 18, 19, and 20.

MALE. Length, 4.76 mm. (average of 5 specimens). The average length of 5 males of *pictus* from Ithaca, N. Y., is 5.76 mm. Weed gives the length of Illinois specimens as 6 mm. This form is closely related to *pictus* but the general color is much darker, the markings more contrasted and therefore much more distinct. The dorsal color pattern is about the same but the median stripe is wider and velvety black on the

abdomen, bordered on each side by silvery white or gray. These white areas become grayish and spotted with black laterally and along the sutures. The tubercles on the body are white-tipped and show as conspicuous white points against the dark background. Sides of abdomen black. Cephalothorax black or mottled black and dark brown; posterior lateral angles marked with whitish or grayish continuous with the lateral light stripes. In most specimens there is a small triangular yellowish spot in front of the eye-tubercle. Eye-tubercle brown or black on the side, the groove yellowish brown.

On the underside of body the coxæ, trochanters, and genital plate, yellow suffused with brown. Coxæ darker towards the tip. Ventral surface of abdomen with a median dark reddish brown stripe extending from the genital plate to tip, bordered laterally with lighter—yellowish, mottled brownish or silvery white.

Legs dark brown, indistinctly annulate with yellowish brown. Tarsi and metatarsi lighter. Metatarsus of first leg with three false articulations. Palpus mottled with light and dark brown. Trochanter of palpus armed ventrally with 4 or 5 spinose tubercles (in *pictus* with 2 large and one small); femur armed ventrally with 9 spinose tubercles of which 5 are large and 4 are small (in *pictus* there are 6, of the large type, longer and more slender than in *nubivagus);* patella without tubercles; tibia armed below with 2 large and several small spine-bearing tubercles, one of the large ones is at the middle and the other one about half way to the base (in *pictus* one of the large tubercles is near the base and the other at the middle of the distal half).

Chelicera yellowish, dorsal surface armed with a few short black tubercles and with scattered, short, stiff, black hairs; first segment short, thick, widened distally; second segment compressed laterally, arched above. In *pictus* there is a strong tooth on the front of the movable finger near the base (Fig. 21, *b*) and a similar but shorter tooth on the second segment just proximad of the base of the immovable finger (*c*) and the inner distal angle back of the insertion of the movable finger is prolonged into a triangular process (*a*). In *nubivagus* the tooth on the movable finger is shorter and blunter (Fig. 19*b*) the tooth back of base of the immovable finger is reduced to a low rounded hump or in some specimens is almost absent (*c*). The inner distal angle is less strongly produced (*a*).

FEMALE. Length, 5.76 mm. (average of 5 specimens). The average length of 5 females of *pictus* from Ithaca, N. Y., is 5.46 mm. Weed gives the length of females from Illinois as 7 mm.

Female much darker than in *pictus*. The median stripe usually less conspicuous. The general coloration of the body usually is a more uniform pepper-and-salt but sometimes the marking of the body is as contrasting as in the male. As in the female of *pictus* the chelicera lack the prominent teeth present in the male. Legs more distinctly banded than in the male. Palpi less strongly spined.

Holotype, male, allotype, female, collected *in coitu*. Numerous paratypes of both sexes. Mt. Mitchell, N. C., above 6,500 feet, Oct. 22, 1923. Abundant on rocks along the trail to the summit—many pairs seen *in coitu*.

Odiellus pictus Wood. Figs. 21 and 22.

North Carolina: Blowing Rock, Oct. 10, 1 ♀; Grandfather Mt., 4,000 feet, Oct. 12, 1 ♀.

Genus LACINIUS Thorell

Lacinius texanus Banks

Georgia: Summerville, Aug. 22, 1910, 1 specimen, J. C. Bradley, coll.

Family ISCHYROPSALIDAE

Genus SABACON Simon

Sabacon cavicolens Packard. Fig. 16.

North Carolina: Grandfather Mt., Oct. 12, 1 ♀; Blowing Rock, Oct. 10, 2 immature, sifting leaves.

First found in America in Bat Cave, Carter Co., Ky. It has since been recorded from Wash., Maine, N. H., N. Y., Calif., Alaska. Roewer (1914) believes this species to be identical with *S. crassipalpis* L. Koch from northwestern Siberia. We do not think that anyone has been able to compare enough specimens from the two regions to prove conclusively that they are the same.

Sabacon mitchelli n. sp. Fig. 17.

FEMALE. Length, 2.7 mm. Cephalothoracic plate dark yellowish brown, shorter, and the sides less convergent anteriorly than in *cavicolens*. Surface of plate smooth, no spines except a few small ones in front of the eye-tubercle. (In *cavicolens* the spines extend across the front and along the sides.) Abdomen light reddish brown. Last thoracic tergite not chitinized, the median pair of short spines arise from shallow pits in the soft integument. (In *cavicolens* these spines are borne on a transverse ridge which is chitinized laterally.) Only the first two abdominal tergites bear very small chitinized plates, the other segments are without such plates. The whole dorsum of abdomen sparsely

clothed with a few scattered small spines. (In *cavicolens* there are seven dorsal chitinized plates on the abdomen and the spines are much more numerous.)

Genital plate, coxæ and trochanters of the legs dark brown, clothed with numerous short erect spines. (In the specimens of *cavicolens* that we have seen these parts are light yellowish.) Venter light reddish brown; integument not strongly chitinized except on the genital and anal plates and a triangular area on each side of the latter.

Cheliceræ dark brown with the base of the immovable claw lighter; first segment cylindrical, twice as long as wide; second segment nearly twice as long as the first, compressed and wider in the middle than at the ends. Inner margin of the immovable finger armed with a broad blunt tooth near the base. (In *cavicolens* the tooth is larger, sharper, and situated near the middle.)

Palpus dark brown, lighter on underside of femur; clothed with short thick spines, much thicker on tibia and tarsus. Legs dark brown, lighter on the femur, clothed with fine appressed hairs and a few erect spines. Ovipositor (extended in the type) long, white except the apical valves which are dusky, and armed with numerous stiff black bristles arranged in irregular transverse rows.

Holotype, female. Mt. Mitchell, N. C., 6,600 feet, Oct. 22, 1923. Collected by sifting moss.

Family NEMASTOMATIDAE
Genus NEMASTOMA C. Koch.

Nemastoma kepharti n. sp. Figs. 23 and 24.

MALE. Length, 1.2 mm. Hard parts of the body very dark brown, nearly black, the connecting membrane white. Legs light brown; femora, patellæ and tibiæ darker, tarsi pale, base of femora nearly white, coxæ nearly black, trochanters light brown. Palpus light brown except the trochanter and base of femur which are pale. Cheliceræ light brown, darker towards base. Hard parts of body finely tuberculate; the white connecting membrane on the sides dotted with small brown tubercles. Eye-tubercle broad and low, eyes widely separated. The dorsal plate much longer than broad, the sides rounded in the hind half but straight and slightly convergent on the front half. The three free tergites rather narrow and not widely separated.

Coxæ and trochanters more strongly tuberculate than the body. Rest of the legs clothed with fine appressed hairs and a few erect short

hairs. Trochanter of palpus fusiform; femur slender, slightly curved; patella a little thicker and shorter than femur; tibia a little longer than patella; tarsus about half as long as tibia, thickened distally and rounded at tip. Femur and tibia without false articulations. The false articulations in the metatarsus variable even on different sides of the same individual. Whole palpus clothed with short erect hairs more numerous on the last two segments. First segment of chelicera strongly constricted near base, the upper surface armed with two minute teeth in front of the constriction; on the ventro-lateral surface there is a small recurved tooth. Second segment compressed laterally and produced at the base into a rather long horn.

Female a little larger than the male. The abdomen is more distended and the posterior segments more widely separated by the white connecting membrane. The second segment of the chelicera is not produced into a horn at base above.

Holotype, male. Type locality, base of Mt. Pisgah, South Hominy Creek, Buncombe Co., N. C., 3,000 feet, Oct. 19, 1923, 12 ♂, 6 ♀. Captured by sifting decaying leaves banked against a log. Western slope of Grandfather Mt., Avery Co., N. C., 4,000 feet, Oct. 12, 1923, 3 ♂. Sifting in similar situation.

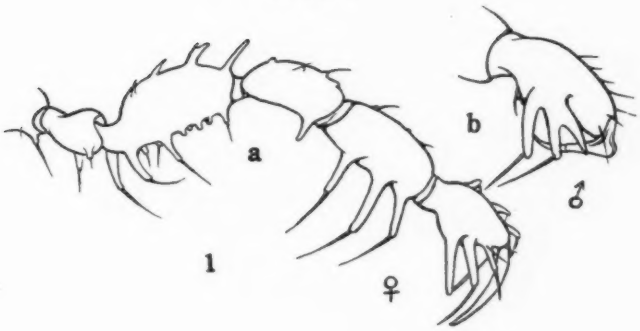
EXPLANATION OF FIGURES

PLATES 1–3

1. *Phalangodes brunnea* Banks (*a*) Right palpus of female, lateral view; (*b*) same view of tarsus of right palpus of male.
2. Same. Lateral view of body.
3. *Phalangodes laciniosa* n. sp. Right palpus of male, lateral view.
4. Same. Lateral view of body.
5. *Phalangodes spinturnix* n. sp. Right palpus of female, lateral view.
6. Same. Lateral view of body.
7. *Phalangodes acanthina* n. sp. Right palpus of male, lateral view.
8. Same. Lateral view of body.
9. *Leiobunum aurugineum* n. sp. Dorsal view of body of male.
10. *Leiobunum speciosum* Banks. Dorsal view of body of male.
11. *Leiobunum bimaculatum* Banks. Dorsal view of body of male.
12. Same. Dorsal view of body of female.
13. *Leiobunum uxorium* n. sp. Dorsal view of body of male.
14. Same. Dorsal view of body of female.
15. *Leiobunum cretatum* n. sp. Dorsal view of body of type specimen; sex doubtful.
16. *Sabacon cavicolens* Packard. Dorsal view of body of female.
17. *Sabacon mitchelli* n. sp. Dorsal view of body of female.

18. *Odiellus nubivagus* n. sp. Dorsal view of body of male.
19. Same. Chelicera, end view; (*a*) triangular process back of movable finger, (*b*) tooth on front of movable finger, (*c*) tooth at base of immovable finger.
20. Same. Right palpus of male, lateral view.
21. *Odiellus pictus* Wood. Chelicera, end view. Lettered as in Fig. 19.
22. Same. Right palpus of male, lateral view.
23. *Nemastoma kepharti* n. sp. Palpus of male, lateral view.
24. Same. Right chelicera of male, lateral view.

PLATE 1



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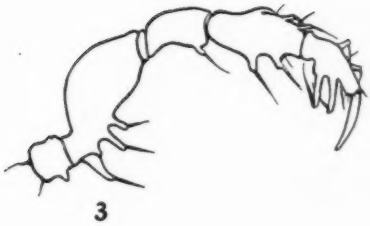

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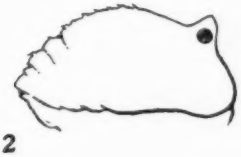

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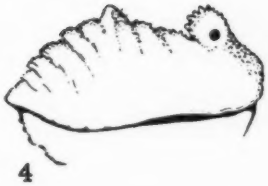

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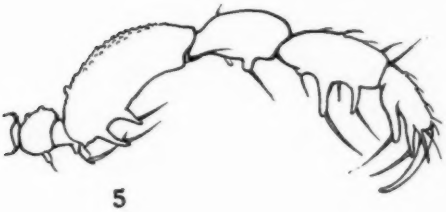

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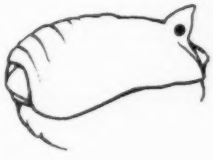

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PLATE 2

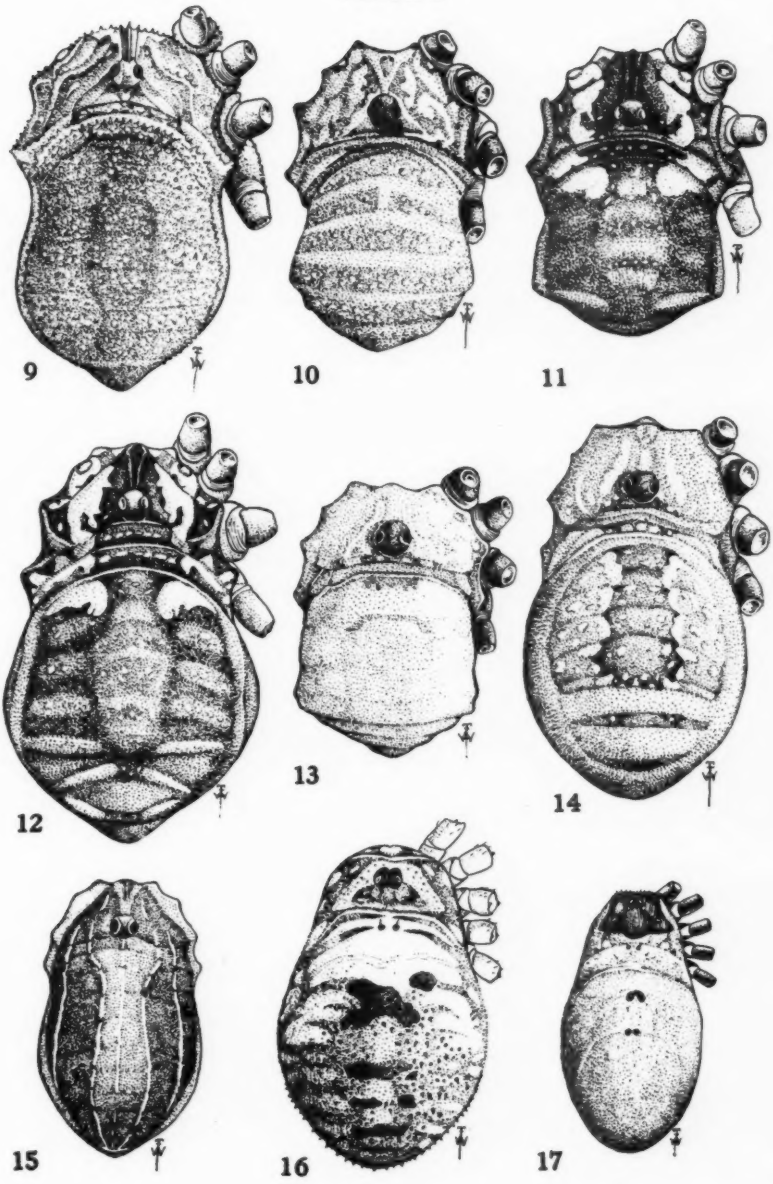

PLATE 3

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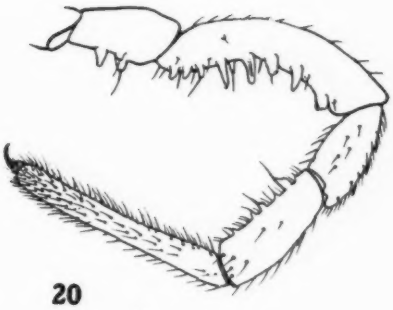

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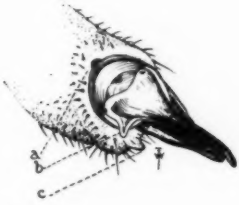

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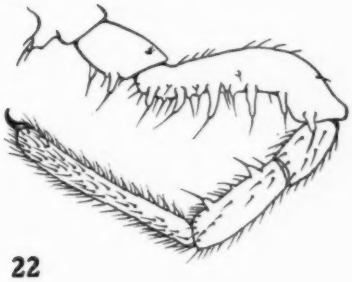

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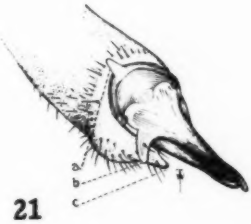

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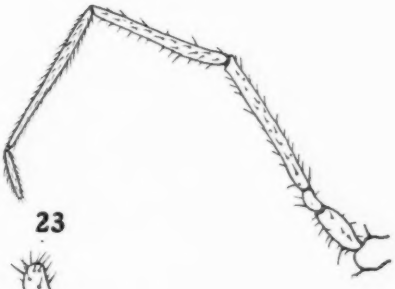

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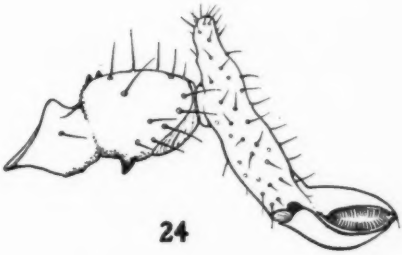

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SOME OBSERVATIONS ON SPORE FORMATION AND DISCHARGE IN LEPTOLEGNIA, ACHLYA, AND APHANOMYCES

By J. N. COUCH

PLATES 4 AND 5

The matter of spore formation and discharge in the water molds has been the subject of much investigation, and certain phases in their development have lent themselves to widely different interpretations. In the following paper the writer presents some observations on the formation and discharge of the spores in *Leptolegnia* and the discharge of the spores in *Achlya* and *Aphanomyces*. These investigations were carried on in the Botanical Laboratory of the University of North Carolina under the direction of Dr. W. C. Coker, for whose encouragement and advice the writer wishes to express his sincere gratitude.

LEPTOLEGNIA

History. The genus *Leptolegnia* was founded by deBary in the year 1888. He beautifully and accurately figures the oögonia but gives no figures of the sporangia or spores and says nothing about the peculiar character of the latter. Coker ('09) first gave certain observations on the peculiar behavior of the spores, stating that in nearly all cases they emerge from the sporangium much drawn out, as long, more or less cylindrical rods with the cilia attached to the center on one side. As soon as they escape, the two ends of the rod begin to fold backward, away from the cilia, and fuse as they go until by complete fusion they lose their identity and form a pear-shaped spore with the cilia near the tip. Petersen ('09) writes that the spores are held together by their flagella, one behind the other, while escaping; and, while confirming the bending back of the ends to reshape the spore to its final form as observed by Coker ('09), he shows (Fig. 2, b.) the two cilia on the end of the emerged spore. Minden ('12) reports the species as common at Hamburg, Germany, but he adds nothing to deBary's observations.

From the conflicting results obtained by Coker ('09) and Petersen ('09) the question arises, are the cilia formed on the side of the elongated rod-like spores or are they formed on the ends of the rods? It was with this problem in mind that a study of the development of the sporangia in *Leptolegnia* was first begun. Soon it was seen that this species with its long, narrow sporangia, in which the loosely packed spores are arranged in a single file, offered the most favorable material yet seen among all

the genera in which the spores are discharged from the sporangium through an apical pore (*Saprolegnia*, *Achlya*, *Protoachlya*, *Isoachlya*, *Aphanomyces* and *Pythiopsis*) for studying the formation of the spores and the problems connected with their subsequent history.

Culture Methods. The fungus was obtained by dropping two or three mushroom grubs into a tumbler containing water, a few decaying leaves, sticks, and trash. By the third day the fungus had appeared on the grub and was giving off spores. Single spore cultures were obtained by dragging a small drop of water containing a few newly emerged spores over a thin, cornmeal agar plate. The position of the spores was then ascertained and marked. About twelve hours later the spores had sent out a sprout. A few of the most favorably located of these were cut out on little agar squares and each square was transferred to a fresh cornmeal agar plate. After thirty-six hours mushroom grubs, termites, and bits of boiled corn grains were inoculated with the fungus, by cutting out little squares of the agar on which a single spore strain of the fungus was growing, and placing the grubs, etc., on the squares in sterile well water in Petri dishes.*

Killing and staining methods. The development of the spores was studied by observations on living material and by killing, and staining the material *in toto* and by killing, sectioning, and staining. For demonstrating the connections between the spores while in the sporangium and the fate of these threads immediately after spore discharge, the method described by Humphrey ('91), with a slight modification, gave satisfactory results. By Humphrey's method the sporangia or emerging spores in water under a supported cover glass are killed by running under the glass a drop or two of one per cent osmic acid. This is allowed to act for a minute or so and then is partly drained off with filter paper. A drop or two of the staining solution, which consists of a moderately strong solution in 90 per cent alcohol of Hanstein's rosanilin-violet, composed of equal parts of fuchsin and methyl-violet, is then applied. Better results were obtained, however, by using 70 per cent alcohol in place of the 90 per cent recommended by Humphrey. Very fine preparations for demonstrating the connections between the spores were obtained by killing, sectioning, and staining. As a killing agent, a chrom-acetic acid solution of the strength used by Trow ('04) gave the most satisfactory results. Davis' ('03) solution of chrom-acetic acid, Chamberlain's ('05) solution of chrom-acetic for marine algæ, and

*For details of culture methods on *Leptolegnia* see Coker ('09); for general culture methods on the water molds see Klebs ('98, '99, '00, '03), Horn ('04), Kauffman ('08), Obel ('10), Pieters ('12), Coker ('23).

Flemming's weak fluid without the osmic acid were tried and gave satisfactory results, but none of these was so satisfactory as Trow's. Sections were cut five microns thick and stained with gentian violet by Gram's method. For studying the nuclear changes attendant on the formation of the spores, material was killed and stained *in toto*. Trow's ('04) solution as a killing agent, followed after washing with iron-alum hæmatoxylin staining, gave fairly satisfactory results. Gram's gentian violet staining, however, gave decidedly the clearest figures of nuclear division. The methods used by Smith ('23) were also tried with satisfactory results.

General morphology. The genus *Leptolegnia*, composed of only one species, is very easily distinguished from other genera of water molds; a detailed description of the species is, therefore, thought unnecessary. Under normal conditions of laboratory culture the life cycle of the fungus consists only of a mycelium made up of a number of sinuous, or nearly straight, long and slender hyphæ which grow out from the grub or other medium in a radial direction and the sporangia to which the former give rise. Sexual organs appear very rarely and then under conditions which cannot readily be accounted for.

Formation of sporangia. Under ordinary conditions of culture, with the room temperature about 22° C., sporangia begin to appear about thirty-six hours after inoculation. The sporangia at first are indistinguishable from the hyphæ.* Indeed any hyphal thread may become a sporangium, and in healthy cultures free from bacteria nearly all of the threads may become sporangia. They are long, straight or sinuous, simple or rarely branched. Usually they are over half as long as the threads themselves and quite often a sporangium may extend down into the substratum. The basal cross wall† where visible is relatively thick, and somewhat shiny and bulges slightly into the sporangium as observed by Rothert ('03) in *Aphanomyces*. Their protoplasmic content consists of a cylindrical layer of protoplasm, which is only slightly if at all denser than that of the vegetative hyphæ, lining the wall. The protoplasm has large granules suspended in it which are highly refractive.

Appearance of the spore origins. The first indication that a thread of *Leptolegnia* is going to become a sporangium is the gradual segmentation of the protoplasmic contents of the thread into enlarged masses along the wall, leaving between these enlarged masses and lining the wall a

*In all the *Saprolegniaceae*, excepting *Aphanomyces* and the present plant, the young sporangia can be distinguished by their denser protoplasmic content and by the easily visible cross wall at their bases.

†It is noteworthy that Petersen ('09) states, "I have not observed with certainty any formation of zoösporangia; evidently cross-membranes are not formed within the mycelium."

thin layer of almost hyaline protoplasm (Fig. 1). The spore origins killed and stained in this stage of development are almost invariably uninucleate (Fig. 22). The writer has never observed one without a nucleus and very rarely has seen one with two nuclei. Careful search has been made to find protoplasmic centers such as the coenocentra in the eggs which might determine the lines of cleavage as has also been done by Davis ('03), but no such structures could be found. In fact as Davis ('03) says, "the nuclei themselves seem to be the ultimate centers of segmentation."

In this stage of development the central region of the thread is almost clear, being occupied by a vacuole containing cell-sap. Thus, these enlarged masses or spore origins appear in optical section to be in two rows on opposite sides of the sporangium, and in this view the origins on one side appear to be approximately alternate with those on the opposite side. A combination of surface, longitudinal, and cross-section studies of the sporangia in this stage of development shows that the spore masses are simply dense aggregates of protoplasm connected by a cylindrical, parietal, lining membrane, and fine strands of protoplasm. Schwarze ('22) in describing cleavage in *Saprolegnia* and *Achlya*, says, contrary to the opinion of Humphrey ('93), Hartog ('95), and Davis ('03), that he is inclined to interpret these strands as gelatinous exudations of the spore initials. In *Leptolegnia* the fine strands connecting the spore initials are easily visible. They can be seen occasionally to shift their position; quite often fine particles can be seen moving along in the strand. They exhibit, so far as observations on such small objects can determine, all the properties of protoplasmic strands. Since this condition in *Leptolegnia* is analogous to the first cleavage stage in *Achlya* and *Saprolegnia*, the connections between the spores in these two genera are doubtless of the same kind of material as in *Leptolegnia*.

Now follows a stage in *Leptolegnia* analogous to the so-called "homogeneous" stage of the spore initials in *Saprolegnia* and *Achlya*. The cleavage furrows which have been extending out between the spore initials separating them from each other finally push out to the wall, thinning down the parietal membrane until it finally ruptures in one or more places as has also been observed by Rothert ('88) in *Saprolegnia*. The moment the parietal membrane breaks a curious change goes over the sporangium, quite similar to that observed in *Saprolegnia* and *Achlya*. The protoplasm which up until now has been coarsely granular becomes very finely sub-granular (Fig. 2). The spore origins lining the

wall lose to a certain extent their undulating character, becoming somewhat ribbon-like in optical section. Simultaneous with the above changes, the protoplasm leaves the wall, moving toward the center of the thread to fuse into a central elongated mass. This movement, however, does not take place simultaneously throughout the entire length of the thread but begins near the middle or near either end of the thread and then passes quickly like a wave throughout. During this event the central vacuole is almost or completely obliterated, as are also the clefts between the spores, and consequently the spore origins almost lose their identity as individuals, in some cases completely; at other times a narrow, clear, space (the remnant of the central vacuole) extending longitudinally between the spores marks their internal boundaries.

Individualization of the spores. With the spore masses now centrally located in an irregular filament in the thread (Fig. 3), the next stage of their development includes the individualization of the spores and the formation and adjustment of the cilia. These steps take place simultaneously.

The spore initials now slowly shift their positions, some moving forward, some backward, in an amœboid fashion until they are arranged end to end in single file (Fig. 4). Meanwhile the young spores contract. The irregularities on the surfaces are drawn in and soon the outlines of the young spores become fairly smooth and even. During these preceding events a considerable space has been formed at the base of the sporangium by the forward movement of the spore origins.

The entire contents of the sporangium now recede, as described by Rothert ('03) in *Aphanomyces*, the backward movement beginning with the spore masses at the sporangial tip where they are more crowded than farther back in the sporangium. This continues for a short while, until all the spore masses are separated by a short distance from each other.

Formation and adjustment of the cilia. To trace the formation of the cilia it is necessary to go back to an early stage when the spore masses were in their original position along the sporangial wall, arranged approximately alternately with one another on opposite sides of the sporangium and connected by the intervening layers of subgranular protoplasm lining the wall. When the spore masses retreat from the wall, moving toward the center, this protoplasm lying against the wall between the spores retreats from the wall with the spore masses. The events here follow somewhat differently from those in *Aphanomyces;* for while in the sporangium of the latter the spore initials are arranged

in a single row, and the wall-lining membrane connecting the spore origins contracts to form a single axil thread, the sequence of events in *Leptolegnia* is complicated by the presence of two rows of spore initials on approximately opposite sides of the sporangium, all connected by a continuous but irregular layer of protoplasm. The spore masses, therefore, on one side of the wall fit into the groove between the spore masses on the opposite side. The protoplasmic wall membrane laterally adjacent to and opposite a spore origin fuses with it almost immediately upon the coming together of the two lines of spore masses. The part of the protoplasmic membrane just at the end of the spores and that laterally continuous with this part of the membrane around the sporangium persist during this event, forming a connection between the spore initials (Fig. 23). This connection gradually contracts into an axil thread, the surplus protoplasm being absorbed by the initials (Figs. 3, 4). Quite often this axil strand splits into two threads before it becomes so small; indeed, so far as observation has gone, the forming of two threads from this axil strand seems to be the general rule (Figs. 4, 5). In the same sporangium, however, some spores are seen connected by one thread while others are seen with two connections at each end (Figs. 6, 9, 18, 19).

As soon as these strands become reduced in thickness to about the diameter of cilia, little papilla-like projections appear at their bases (Figs. 5, 6). These little papillæ doubtless contain the so-called "basal granule" or "basoplast" of the cilia, and with their appearance the connecting threads may be said to be actually transformed into cilia. These little projections rock back and forth in a jerky fashion, transmitting to the connections an oscillating motion. As a result of this motion the young spores are rocked and jerked feebly. As the motion continues and increases in vigor these connecting threads become longer.

Quite often these threads may be jerked so vigorously as to become disconnected at one end, in which case the papillæ move slowly around to occupy a lateral position on the rod-shaped spore, the position which, when the spore reshapes itself, will be the anterior end of the spore. If the sporangium is rather slender, the contained spores with laterally placed cilia may retain their rod-shape until after they are discharged. Such a condition as has just been described accounts for the description and figures of the spores as given by Coker ('09). If, however, the emptying is slightly delayed at this stage and the sporangium is wide enough to permit free rotatory motion of the spores, the ones with free, laterally placed cilia may reshape themselves into a pip-shaped spore.

Usually, however, with the spores still connected at their ends, events proceed as follows. As a result of the backward movement of the spore origins and their individual contraction, which has been described above, the young spores have become separated by a distance about equal to half their length. The spores now swell so that they push against each other, becoming roughly cylindrical in shape (Figs. 7, 8). When the spores begin to swell, a vacuole appears in each spore which increases in size as the spore itself enlarges. During this swelling and partly as a result of it, the front spore is pushed up against the sporangial tip.

The sporangial tip now gives way and the front spores rush out with great momentum; the emptying of the other spores proceeds moderately fast, becoming slower as the number of spores within the sporangium decreases. As the momentum of the emerging spores becomes less and they become separated from one another, the connecting threads between the spores become visible. Usually two connecting threads, at times only one, can be seen on the end of each spore, and even when two spores are some distance apart and the threads cannot be seen, yet the ends of the spores are pulled out into one or two little papillæ indicating the presence of the connections. In cases in which one would expect the connections to be broken, as, for example, when most of the spores have emerged and a few are left in the sporangium to emerge tardily, the anterior end of the front spore is invariably rounded.

The threads connecting the spores while in the sporangium and during their discharge are almost immediately or immediately broken the moment the spores get out into the water. Usually two threads are left on the same end of a spore and not one thread on each end (Figs. 10, 11). The papillate bases of these two threads are a considerable distance apart (Figs. 10, 11). The newly emerged, rod-shaped spore indicates by its movement, which is in a line with the long axis of the spore, the position of the propelling organs. This movement, however, is very brief for quickly the rod-shaped spores assume a V-shape, tumbling over obliquely and moving about in an aimless fashion. As the spore bends, the cilia move around from their former position on the end of the rod to the side of the spore (Figs. 12–16). The two ends of the V continue to bend toward each other, fusing as they come together until a pear-shaped spore has been formed (Coker, '09; Petersen, '09). The cilia, now with their bases very close, have, meanwhile, moved around to occupy their normal position near the small end of the spore (Fig. 17). The reshaped spore with its propelling cilia in front now swims away.

Nuclear structure and division. The structure of the resting nucleus is essentially the same as that described by Trow ('99, '04) for species of *Achlya* and by Smith ('23) for *Saprolegnia dioica*, though the observations of the writer are not in accord with the latter's as regards the interpretation of the parts of the nucleus.

The method of nuclear division in the hyphæ has been a matter on which observers have disagreed. Humphrey ('93) described the nuclei as dividing amitotically. Hartog ('95) described the process as being a transitional form between mitosis and amitosis. Trow ('95) described the nucleus of the germinating zoöspores and germinating eggs (oöspores) as dividing directly. The same author ('99) was unable to find dividing nuclei either in the germinating zoöspores or in the mycelium of *Achlya americana* var. *cambrica*, but in the germinating eggs (oöspores) he asserts with certainty that nuclei have been seen in all stages of karyokinesis (Trow's Figs. 60–70). It seems that Smith ('23) overlooked Trow's ('99) observations on the dividing nuclei of the germinating eggs. Smith ('23) studied the nuclei in the mycelium of *Saprolegnia dioica* and reports that the nuclei divide amitotically.

In actively growing threads of *Leptolegnia* dividing nuclei may be found fairly evenly distributed throughout the length of the thread. The process of nuclear division in the threads of *Leptolegnia* is somewhat as follows: The central body enlarges slightly, becoming much more vesicular in structure (Figs. 4–10). The deeply staining material in the central body then becomes apparently broken up into several chromosomes (Figs. 4–10), which lie so close together and are so small that their exact shape and number are difficult to determine; the usual number, however, seems to be from six to eight. At this stage in favorably placed nuclei the so-called centrosome can be seen on the nuclear membrane with a deeply staining line or lines passing from it to the chromosomes (Figs. 4, 6, 8, 9). Although the division of the centrosome and rotation of one of the daughter centrosomes around to the opposite side of the nucleus has not been fully traced through subsequent stages in the nuclear division, its behavior seems to be essentially the same as that described by Trow ('04) in the oögonial nuclei of *Achlya polyandra* and *A. deBaryana*, and by Mücke ('08) in the oögonial nuclei of *A. polyandra*.

A rudimentary spindle which in some cases apparently connects up with the centrosome is formed on which the chromosomes are arranged in an irregular way (Figs. 11–13). The chromosomes arranged on the spindle are not very distinct as individuals but appear to be partly fused together. During this stage, which seems to correspond with the

metaphase, the chromosomes do not seem ever to arrange themselves in an equatorial plate nor has the actual splitting of individual chromosomes been observed.

The chromatin material then begins to move toward the poles (Figs. 14–16). Faint lines which may be either spindle fibers or little chromatin granules left in the wake of the separating chromosomes can be seen connecting the two polar masses of chromatin (Figs. 16–18). Not rarely in this stage, which seems to correspond to the anaphase, indications of astral rays may be observed at the poles.

The lines between the two masses of daughter chromatin fuse together forming out of the whole body a dumb-bell-shaped structure (Fig. 21). The two daughter nuclei now acquire indistinct nuclear membranes and meanwhile the chromatin material has fused to form the characteristic central body of the resting nucleus (Fig. 21).

Similar results were obtained with *Achlya orion* and the sprouting spores of *Thraustotheca achlyoides* (Journ. E. M. Sci. Soc. 39: 112. 1923).

Nuclear division always precedes the formation of sporangia, no dividing nuclei ever having been observed in a young sporangium, corroborating the results obtained by all other observers on this point. Nuclei, however, which appear to be undergoing degeneration have been observed in young sporangia (Fig. 21).

CILIA FORMATION IN ACHLYA

Cornu ('72) was the first to assert that the spores of *Achlya* were furnished with cilia during their emergence from the sporangium. He says, in effect, that the spores possess two anterior cilia visible under favorable conditions and that they usually adhere one to another by means of these cilia. Cornu's assertion of the presence of cilia was corroborated by Hartog ('87) for *Achlya polyandra* Hild. and *A. recurva*, by Humphrey ('93) for *A. americana* and *A. polyandra* Hild., and by Coker ('23) for *A. caroliniana* and *A. apiculata*. On the other hand, deBary ('84) says that in the genera *Achlya* and *Aphanomyces* the spores are discharged without cilia and without autonomous movement. Rothert ('90 and '03) and Horn ('04), for *A. polyandra*, affirm deBary's statement. Humphrey ('93) claims (contrary to Cornu's assertion) that the spores are held together by no material connections while Rothert ('90 and '93) maintains the presence of connecting threads between the emerging spores of *Achlya* and *Aphanomyces*.

From these apparently conflicting statements the following questions

arise. Are there any material connections between the emerging spores? If so, what is the nature of these connections and are the spores equipped with cilia during and immediately after emergence? In an attempt to answer these questions, the spores were studied by killing and staining them during emergence. In the case of *A. dubia* Coker the spores were killed when the sporangium was empty except for a very few spores. At the instant when the osmic acid hit the cluster of spores at the sporangial opening, they spread out into an open cluster (Fig. 27). It was noticed, upon shaking the drop of water in which the specimen was suspended, that the spores moved in unison with the movement of the sporangium as though they were surrounded by a viscous fluid which held the spores together and attached the entire mass to the sporangial tip. Upon moving the sporangium with a needle for a distance of about two millimeters, the spores followed along as though weakly held together by some sort of connections, confirming the observation of Coker ('12) as to a tangible connection, which, however, he thought to be a jelly. Upon staining the spores, many of them were found to be held together by delicate threads. A few of the spores still remained in the sporangium. They were spindle-shaped with their long axes parallel to the length of the sporangium. The small ends of the spindle-shaped spores narrowed down into delicate threads which connected the spores. Outside of the sporangium sometimes as many as three spindle-shaped spores were still held together by these delicate threads (Fig. 28). Very frequently two spores were held together in this fashion (Fig. 29). A good many of the spores had broken their connecting threads, these threads still being evident on the opposite ends of the spores (Fig. 30). On other spores these threads were seen moving around from the opposite pointed ends of the spores approaching each other (Figs. 31–34), and on still others these threads had come to occupy the position of cilia (Fig. 35).

Similar results were obtained with *A. orion* (Figs. 25, 26), *A. flagellata* (Figs. 36–39), *A. apiculata* var. *prolifica* and *A. conspicua*.

OBSERVATIONS ON APHANOMYCES

Observations were made also on *Aphanomyces* to determine if there were cilia. The development of the sporangia was followed through on living material as has been done by Rothert ('03) with a general corroboration of his results as regards the developing of the sporangia. In regard to the cause of spore discharge and the cause of their collecting

in a ball at the sporangial tip, the observations of the writer, however, are not in accord with his.

It was observed how the parietal protoplasmic layer between the spores thins down to form very delicate connections between the spores (Figs. 35, 36, 37), and how these threads persist between the spores during their discharge (Fig. 37), as observed by Rothert ('03).

During spore discharge, Rothert ('03) records that the spores never seem to touch the sporangial wall, concluding from this that there is a gelatinous substance lining the wall which, through its swelling, keeps the spores from touching the wall and also plays an important part in forcing them out. The observations of the writer seem to negative the presence of this gelatinous substance. In numerous observations on discharging spores they always seem to be in contact with the wall unless the sporangium is unusually wide and the spores are emerging with great rapidity (Fig. 37); various stains, moreover, have failed to demonstrate the presence of any gelatinous substance.

In addition to the observations on living material, spores were killed in the act of emerging and stained with the cilia stain (see above). The emerged spores were in several clusters (the largest group being at the sporangial tip), the spores in each of which were held together by the threads. Many of the spores were beginning to round up and encyst, the connecting threads having become very short between some spores and having almost entirely disappeared between others. As the connecting threads are shortened, the spores are, of course, drawn closer together until their surfaces are in contact. A cellulose membrane is quickly secreted by each spore encysting it. The spores after encystment stick together by the mucilaginous surfaces of the newly secreted, cellulose walls, as is clearly evidenced by the fact that even after the spores have emerged from their cysts the old cellulose membranes still cling together.

A few disconnected spores showed the threads approaching each other on the same end of the spore, but none was seen occupying the position of cilia.

DISCUSSION

Humphrey ('93) accepted the theory advanced by Hartog ('88) that the close pressing together of the spores during their emergence, as well as their encystment at the sporangial tip, was due to a mutual attraction between the spores which the latter called adelphotaxy. Humphrey also states, in the same paragraph, that there are no material con-

nections between the spores, and that they are, at least in some species, provided with cilia during their escape from the sporangium.

It seems quite evident now that this close pressing together of the emerging *Achlya* spores is due not to any hypothetical adelphotaxy between them but rather is due to the existence of the delicate protoplasmic connections, as Rothert ('03) suggests.

The arrangement of the spores after their escape into a hollow sphere is also due to the presence of these delicate protoplasmic connections which contract the moment the spores reach the exterior of the sporangium. Rothert ('03) suggests that the arranging of the spores in a hollow sphere is conditioned by the presence of a sticky substance, part of which is discharged with the spores, forming a ball of jelly in the surface of which the spores arrange themselves. The great improbability of the presence of any accompanying gelatinous substance is shown when osmic acid is applied to a discharging sporangium. If the substance were there, the osmic acid would so fix and harden it, as Humphrey ('93) suggests, that the spores which had arranged themselves in a hollow sphere would remain fixed in that position. But when the acid is applied, the spores spread out in an open cluster, thus negativing the presence of a gelatinous substance. Proper staining, as seen above, reveals delicate protoplasmic connections between many of the spores. The acid, of course, fixed the connecting threads, many of them in the act of contracting (Figs. 5 and 6). The threads are drawn in and absorbed by the spores and by this process the spores are arranged in a hollow sphere, whereupon they immediately encyst.

The cilia observed by Cornu, Hartog, Humphrey, and Coker are evidently these connecting threads which have been broken during and immediately after emergence and which have come to occupy the position of cilia on the small, anterior, pointed end of the spore.

The matter of cilia formation in the swarm spores of the fungi has not received much attention. The general conception of the formation of cilia is that stated by deBary ('84) who describes the cilia as springing from a definite spot on the surface of the spore as processes of the peripheral layer of protoplasm. According to Rothert ('88) the cilia appear as slow outgrowths at first like little, short, straight bristles which show faint oscillations. This method of cilia formation is easy to observe in the spores of *Achlya* or *Saprolegnia* when they are nearly emerged from their cysts. It would be a much more difficult matter to determine how the cilia are formed in the sporangia of *Saprolegnia*, since the spores are so crowded. It is quite likely, however, that they are formed from connecting threads.

SUMMARY

The cilia in *Leptolegnia* are formed by the thinning down of the parietal membrane between the spore origins into one or two strands which connect the spores, as a rule, until after discharge. Upon discharge these threads are broken and as the spore reshapes itself they move around to occupy the normal position of cilia.

The nuclei of the vegetative hyphæ divide by indirect division, no nuclear division occurring within the sporangia, the supernumerary nuclei degenerating, leaving, as a rule, a single nucleus in each spore origin. Occasionally two nuclei remain.

The spores in the species of *Achlya* investigated are held together while emerging by threads which probably originate from the parietal lining membrane. Upon discharge the contraction of these connecting threads plays an important part in causing the spores to encyst in a hollow sphere. Killed on emerging, the threads were in some cases seen to be on opposite pointed ends of the spores. In other cases they were found to be in the normal position for cilia. All intermediate stages between these two positions occur.

The spores of *Aphanomyces* are held together by threads formed by the contraction of the parietal membrane. These threads persist during spore discharge, as observed by Rothert, and upon discharge doubtless play an important part in causing the spores to collect in a ball. None of the threads was seen occupying the position of cilia.

In the light of the above observations, Rothert's theory of a ball of jelly or Hartog's theory of adelphotaxy is unnecessary to explain the collecting of the spores in a ball at the sporangial tip.

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EXPLANATION OF PLATES

PLATE 4

FIGS. 1–24 (*Leptolegnia*)

Fig. 1. Optical section of a young sporangium showing the spore initials on one side of the sporangium alternating with those on the opposite side.

Fig. 2. Showing the spore initials leaving the wall of the sporangium, homogeneous stage of Büsgen.

Figs. 3–6. Stages in the formation of the connecting threads.

Figs. 7–8. Stages in the swelling of the spores just before emerging.

Fig. 9. Emerging spores showing two connections in one place and one in another. The ciliary papilla is very evident in this stage.
Figs. 1–9. ×402. Drawn from life.

Figs. 10–17. Emerged spores showing different stages in the reforming of the spore and the adjustment of the broken connecting threads or cilia. Humphrey's cilia stain. ×552.

Figs. 18, 19. Showing sections of sporangia in which the spores were killed during emergence. Some spores were held by one thread, others by two. Gram's stain. ×810.

Fig. 20. Section of sporangium showing spores with connecting threads, some of the connections apparently passing into the nucleus and connecting up with the central body. Gram's stain. ×552.

Fig. 21. Showing end of hyphal thread just before the spore initials appear with a few degenerating nuclei. Iron hæmatoxylin. ×810.

Fig. 22. Optical section showing uninucleate spore origins. Iron hæmatoxylin. ×810.

Fig. 23. Spores stained to show nuclei in stage about the same as Fig. 3. Iron hæmatoxylin. ×810.

Fig. 24. Spores ready to emerge showing several pairs of connections. Iron hæmatoxylin. ×552.

Fig. 25. Sporangium of *Achlya orion* showing spores killed in the act of emerging. They are pressing closely together and a good many of them show connections. Humphrey's stain. ×222.

Fig. 26. Two spores of *A. orion* showing connecting threads. Humphrey's stain. ×402.

Fig. 27. Showing a cluster of spores of *A. dubia* killed with 1 per cent osmic acid when nearly all of them had emerged. See text. Semi-diagrammatic. ×107.

Figs. 28–35. Stages in the reshaping of the spores of *A. dubia* and the moving around of the broken connecting threads to occupy the position of cilia. Figures drawn from spores killed and stained immediately upon emergence. Humphrey's stain. ×402.

Figs. 36–39. Stages in the reforming of the spores of *A. flagellata* showing how the connecting threads become broken and move around to occupy the position of cilia. Humphrey's stain. ×402.

Fig. 40. Sporangium of *Aphanomyces lævis* showing spore origins connected by the cylindrical parietal membrane a few seconds before the protoplasmic contents left the wall. ×402.

Fig. 41. Two spores in the same sporangium as that shown in Fig. 40, showing the "parietal membrane" contracting into an axil thread. ×402.

Fig. 42. Spores discharging showing the long-drawn axil thread connecting two spores. ×402.

Fig. 43. Showing a spore emerging tardily. ×402.

Figs. 40–43. *A. lævis.*

Figs. 44–47. Emerged spores of *A. stellatus* held together while encysting. Humphrey's cilia stain. ×429.

PLATE 5

Figs. 1–21. *Leptolegnia.* Figures drawn from hyphæ.

Figs. 1–3. Resting nuclei showing the central body suspended by a delicate network of threads. Slight irregularities are visible on the membrane but these are not concolorous with the central body.

Figs. 4–10. Various stages in the prophase of mitosis.

Figs. 11–13. Metaphase.

Figs. 14–18. Anaphase.

Figs. 19–21. Telophase.

Figs. 22–31. *Thraustotheca achlyoides.* Figures drawn from sprouting spores.

Fig. 22. Spore with resting nucleus. The middle nucleus is in anaphase, the other in prophase.

Figs. 23–25. Prophase.

Figs. 26–28. Metaphase.

Figs. 29–31. Anaphase. Fig. 30 was especially clear in showing individual chromosomes and spindle fibers.

All the above figures were drawn from material stained by Gram's method.

Figs. 32–35. *Achlya orion.*

Fig. 32. Resting nucleus showing threads suspending the central body.

Fig. 33. Prophase.

Fig. 34. Anaphase.

Fig. 35. Two daughter nuclei which have just completed division.

All figures ×2160.

PLATE 4

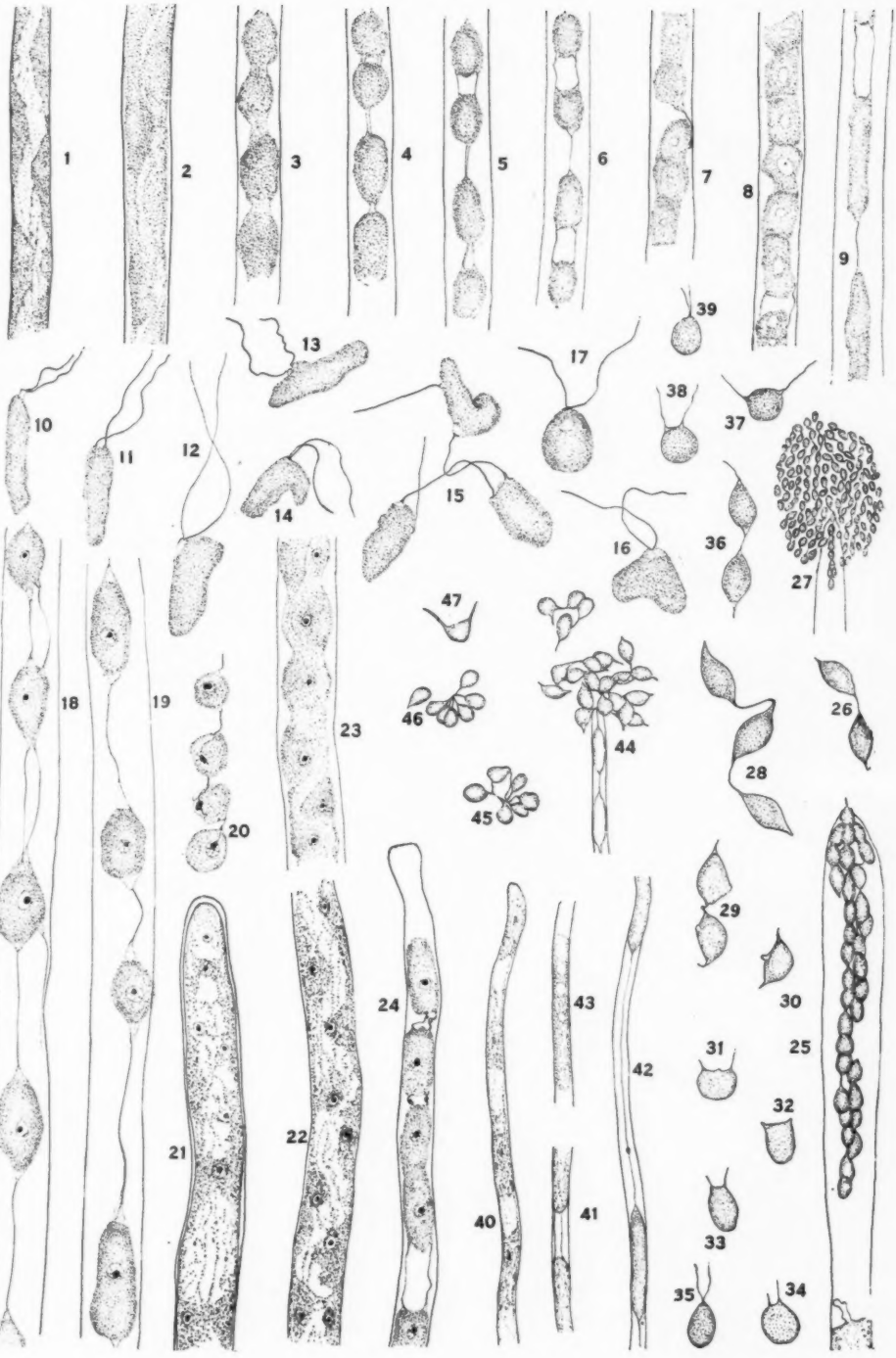
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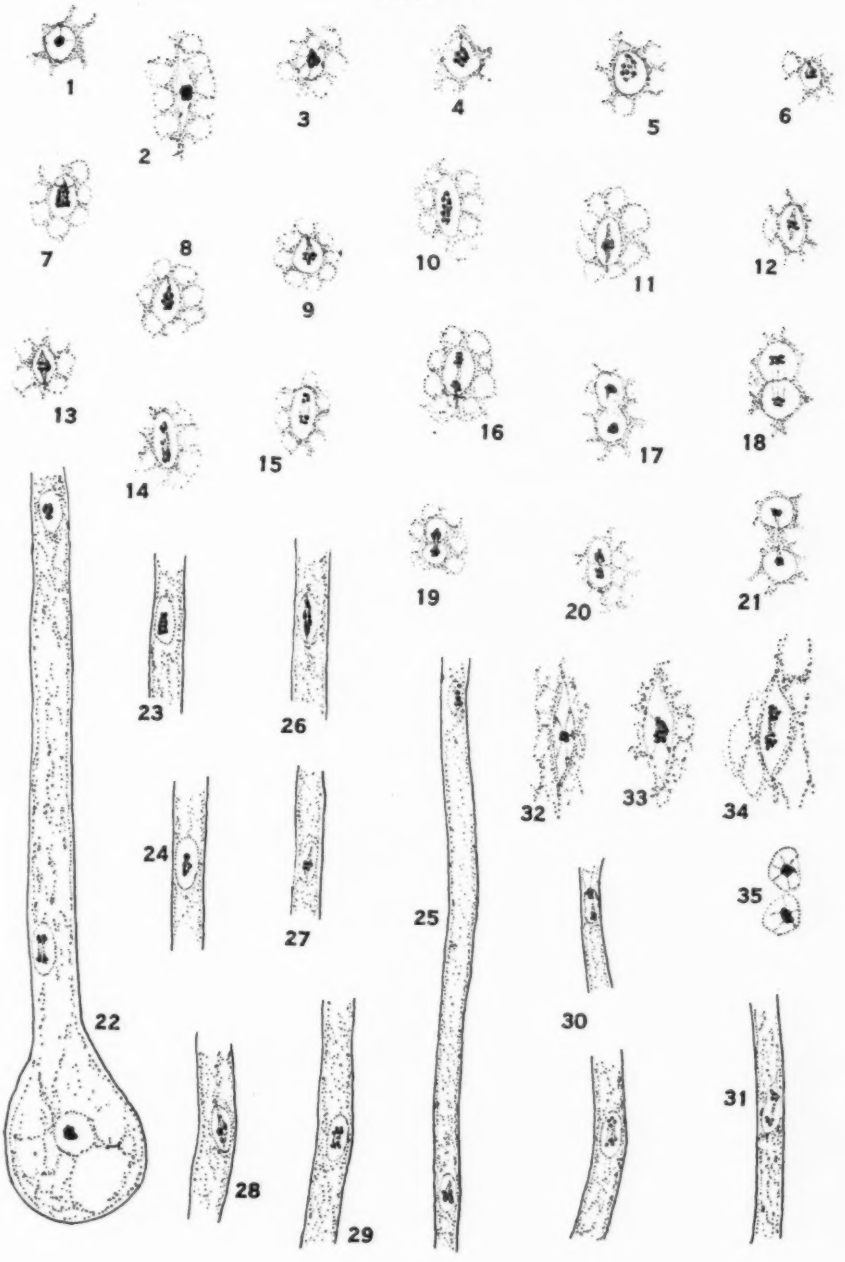
PLATE 5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NOTES ON WOODY PLANTS

By W. W. ASHE

Quercus leiodermis sp. nov.

A tree with spreading branches 18 to 25 m. in height and with a stem becoming 5 dm. in diameter. Bark on the lowest portion of the trunk of old trees dark gray, deeply furrowed and cross-checked, on the upper portion of the stems of old trees and on young trees smooth and light gray. Shoot of the season at first pubescent; when mature, rather slender, bright orange-tan, angled and glabrate, the narrowly conical buds acute, the scales puberulent. Leaf-blades ovate, broadly ovate, or elliptic in outline, 10–14 cm. long, 7–16 cm. wide, with 2 or 3 pairs of lobes, separated by deep sinuses, usually sharply ascending, frequently narrowly triangular and entire, or, especially on lower leaves, with the upper lobes broad at apex and more or less notched, dark green and lucid above, dull and slightly paler beneath; pubescent below as they unfold, soon glabrate; the 2–4 cm.-long petioles and the slender veins yellowish green. Acorn maturing the second year, ovate, 12–16 mm. long, nearly glabrous when mature; cup covering about one-half of the nut, turbinate or hemispherical with a rounded base, scarious at the margin, and thickened below by several rows of closely appressed imbricate scales which are obtuse, glossy red-brown and finely but densely pubescent.

Hills south of Kansas City, Missouri; B. F. Bush and W. W. Ashe, September, 1923. The proposed species differs essentially from *Q. velutina* and its variety *missouriensis* in the smaller, narrower, and more glabrous foliage, often with entire acuminate lobes, in the prevailingly smaller fruit, with appressed and not squarrose scales on the cup, which is generally rounded at base, and in the smooth light-colored bark which is strikingly in contrast with that of the eastern black oak. The pubescent scales on the cup separate it from all forms of the Spanish oak (*Q. coccinea*), the scales of which are puberulent or glabrate. Locally called smooth-barked oak.

Quercus similis n. n.

Q. ashei Sterrett. Journ. Mitchell Scientific Society **37**: 178. 1922. Not ×*Q. ashei* Trelease. Proc. Amer. Phil. Soc. **56**: 44. 1917.

Q. stellata var. *paludosa* Sargent. Bot. Gaz. **65**: 441. 1918. Not *Q. paludosa* Petgold (1864) nor *Q. paludosa* Dippel (1892).

In an examination of a large number of groups of trees of this form, both in Louisiana and in Texas, no specimens were found which seemed to show any wide deviation from the characters as described by Sterrett, nor any which indicated an approach to *Q. stellata*.

Quercus arkansana caput-rivuli n. c.

Q. caput-rivuli Ashe. Rhodora **25**: 179. 1923.

In the original description of *Quercus caput-rivuli* there is the suggestion that it may be a hybrid. Additional information, however, seems to show that it is not a hybrid, but is probably best considered as a variety of *Q. arkansana* Sarg. When the description was prepared, fruit of *Q. arkansana* had not been seen. It is about one-half larger than that of the eastern tree, which occurs not only near Crestview, Florida, but has been found in Clay County, Georgia, growing on similar sites, and is the form reported by Sargent (Manual, Ed. 2, under *Q. arkansana*) from Pike County, Alabama, where it was collected by Dr. Roland Harper.

Ilex glabra austrina var. nov.

Leaves broadly obovate or almost orbicular in outline, 1.3–2 cm. long, nearly as wide, shallowly 3-notched at apex, thicker and more succulent than in the type; fruit and twig as in the type. A shrub of the same general habit as the type and growing often abundantly with it in wet flat woods of southeastern Georgia.

Ilex arenicola sp. nov.

A shrub or small tree with the twigs and bark of *Ilex opaca*. Leaves obovate, 3 to 6 cm. long, usually cuneate and entire at the base, rounded at the often broad apex, subentire or bristly toothed, yellowish green, frequently with revolute margin; fruit apparently similar to that of *Ilex opaca*. The proposed species is common near Astor Park, Lake County, Florida, growing in the deep sandy soils of the "scrub," with *Hicoria floridana* (Sarg.) Ashe, *Pinus clausa*, and *Quercus chapmani* Sarg., species which form much of the growth of the scrub. It differs from *Ilex opaca* chiefly in the much smaller, yellowish green leaves which have prevailingly cuneate bases.

Ilex attenuata hyb. nov.

Twigs at first usually puberulous, at length often glabrous and pale yellowish gray or olivaceous, angled, buds dark brown, pubescent.

Leaves oblong, oblong-obovate, or oblong-ovate, mostly acute at base and abruptly taper-pointed at apex, the blades 5–8 cm. long, 2.5–3.5 cm. wide, dark yellowish green above, paler beneath, firm and brittle, entire and slightly revolute on margin or, especially on vigorous shoots, spiny or spinescent toothed. As they unfold, puberulent above on midrib and pubescent below, especially on midrib; petioles about 1 cm. long, usually pubescent at first. Flowers, appearing (in west Florida) the last of April or early in May, about a week later than those of *Ilex opaca*, are in clusters of 3–6, on pubescent pedicels and peduncles; calyx lobes, in specimens examined, 4, 1 mm. long, acute, ciliate; petals about 3 mm. long, obtuse; fruit 6–8 mm. thick, solitary or in clusters of 2 or 3 on common pubescent peduncles 0.5–1 cm. long, bright red but not waxy; nutlets, in specimens examined, 4, white, mostly with 2 shallow grooves on back, and low anastomosing ridges on back as well as on the sides.

A tree with habit and bark similar to those of *Ilex opaca*. Streamheads west Florida near Mossyhead Post Office, Walton County, growing with *Ilex opaca*, *I. dahoon*, *Cyrilla*, and *Quercus laurifolia*. It is probable that this is a hybrid between *I. opaca* and *I. dahoon*.

Ilex Beadlei var. **lævis** var. nov.

There is often associated with *Ilex Beadlei* Ashe a glabrous or glabrate form. Specimens of this form have usually been referred to *I. monticola* and have been a factor in confusing *I. Beadlei* with *I. monticola* var. *mollis*. Both *Ilex Beadlei* and its proposed variety *lævis* at altitudes of 1,800 to 2,500 feet flower about one week later than *I. monticola* at altitudes of 4,000 to 4,500 feet. The leaves of *I. monticola* are prevailingly oblong, acute at base and long taper-pointed. Those of the proposed variety are oval or ovate, and rounded or obtuse at both ends. The fruit of *I. Beadlei* and its variety *lævis* is about 2 mm. thicker than that of *monticola* and their seed about 1 mm. longer. *I. monticola* in the Southern Appalachians is prevailingly arborescent or subarborescent, while *Beadlei* is always shrubby. There seems to be no overlapping of their distributions; *monticola* is distinctly Alleghanian, *Beadlei* and its variety *lævis* essentially Carolinian. Type of *lævis* from along the Hiwassee River, Cherokee county, N. C., near Appalachia, Tenn. W. W. A.

Castanea ozarkensis var. **arkansana** n. c.

Castanea arkansana Ashe. Bull. Tor. Bot. Cl. **50**: 361. 1923.

It is probably best to regard *C. arkansana* as a glabrate variety of *Castanea ozarkensis*, the common chinquapin of the Ozark Mountains.

Certain individuals seem very distinct but intermediate forms occur. The important characters which distinguish the variety are the scant pubescence on sun leaves which are glaucescent on their lower surface. Since the preparation of a recent article on *Castanea*, additional information has been secured which seems to show that the variety *arkansana* extends in the extreme western portion of the state of Arkansas, south of the Arkansas River as far as the neighborhood of Mena. It is essentially, however, an Ozarkian form, the exact distribution of which is not yet determined. At or near Mena, Arkansas, *C. Margaretta* Ashe also occurs, and *C. Margaretta* seems to be the only species in the foothills of McCurtain County, Oklahoma, and in Faulkner County, Arkansas, and to the southward.

Castanea Margaretta augustifolia var. nov.

This differs from the type only in the very narrow foliage. It is common in Bibb County, Alabama, in the vicinity of Lawley and for 20 miles westward.

Castanea Margaretta arcuata var. nov.

This differs from the type in the stouter usually pubescent twigs, arcuate branchlets, and long drooping twigs. It is the prevailing form in Hardin County, Texas, where it forms in places a conspicuous part of the "thicket" growth.

Hicoria carolinæ-septentrionalis australis n. c.

Hicoria australis Ashe. Bull. Ch. Mus. **14**: 12. 1918.

This tree was described from material collected in eastern North Carolina. Material from Alabama, on alluvial lands of the Alabama River near Montgomery, seems to differ only slightly from that from North Carolina, and indicates an approach towards *H. carolinæ-septentrionalis*, so that it should probably be regarded as a variety of that species having large fruit and broader leaflets and growing in swamps or on alluvial lands within the coastal plain.

Hicoria mollissima sp. nov.

A tree 15–20 m. tall, with a long crown, rather short trunk, which becomes 4–6 dm. thick, and close bark of rather low netted ridges. Twigs slender, 2.5–4 mm. thick, glossy red-brown, glabrous at least

when mature; terminal buds ovate or oblong-ovate, 9–12 mm. long, acute; the outer scales keeled, acute or awned, sparingly pubescent on back; inner silky pubescent, not swelling during early winter. Leaves on fruiting twigs 2–4 dm. long, longer on vigorous shoots, of 5 or 7, usually 7, rarely 3, leaflets; upper leaflets usually about 1 dm. long, oblanceolate and narrowed at base, the terminal long-stalked; middle pair oblong-ovate; lower pair much shorter ovate or broadly ovate; all abruptly acute or acuminate, sharply and finely serrate; when mature glabrous above, soft pubescent beneath, and petiole usually so. Fruit obovate, usually with a thickened stipe, sometimes nearly ficiform, from 2.5–3.1 cm. long, 2.5–3.6 cm. thick, nearly round in cross sections; the husk smooth and practically free from resinous globules, 2–3 mm. thick, seldom splitting by 2–3 sutures even to the middle, and not freeing the light brown, scarcely flattened nut which is 2.3–2.6 cm. thick, slightly longer, more or less angled, the walls about 4 mm. thick. Calyx, of pistillate flower, broadly ovate; stigma small, the two cornuform divergent lobes about 1.5 mm. long.

Tishomingo County, Mississippi, along Yellow Creek, October 7, 1921, type locality; 6 miles south of Iuka, October 8, 1921; common along streams throughout the county; Sabine County, Texas, 4 miles east of Hemphill, October 21, 1921; Winn Parish, Louisiana, September 1921; all W. W. A.

The proposed species resembles in its foliage *H. leiodermis* (Sarg.) of the lower Mississippi Valley region, but it has larger and relatively broader leaflets and is more copiously pubescent. The fruit and stigma are entirely different. By its fruit and small stigma it is allied to the black hickory group, and is most closely related to *H. similis* of the southeastern states.

Viburnum rufidulum floridanum var. nov.

A small tree with the general habit and bark of the type, and differing from the type essentially in its oblong leaves and short, 10–12 mm.-long, subglobose, scarcely glaucous fruit. The only form in Walton County, Florida, where frequent on the edges of hammocks. W. W. A., April and October, 1923.

Viburnum rufidulum margarettæ var. nov.

This differs from the type in its very broadly ovate, often suborbicular leaves, sometimes subcordate at base; and prevailingly large, 14–18 mm.-

long, and densely glaucous fruit. Eastern Texas. Type from near Groveton where it is the prevailing form. W. W. A., September, 1923.

Viburnum Bushii sp. nov.

A slender shrub, 3–4 m. tall, stems usually clustered. Leaves when mature oblong-lanceolate, acute or acuminate at apex, mostly rounded at base, the blades 5–10 cm. long, thin, finely serrate, glabrous or when young the midrib below and the often winged, 1 cm.-long petiole covered with short scurfy purplish brown hairs. Flowers in ample, 5–7 cm.-wide, 4-rayed, nearly sessile, glabrous cymes. Drupes when mature black, sparingly pruinose, subglobose, 7–10 mm. long, nearly as thick; seed thin, nearly flat on one surface, slightly convex on the other, about 7 mm. wide, 8–9 mm. long, rounded at both ends. Flower buds 5–7 mm. long, much flattened, varnished red-brown.

The proposed species seems to occur from northwestern Arkansas to southern Illinois. B. F. Bush and W. W. Ashe, Jackson County, Missouri, September 11, 1923, type. There are also referred here Bush, Nos. 10029 and 10237 from same locality; No. 5627, Jasper, Missouri; Schneck, Patton, Illinois, 1879; W. W. A., Shannon County, Missouri, and near Cass, Franklin County, Arkansas.

It is most closely related to *V. prunifolium*, though sometimes suggestive of *V. lentago*, but there is no suggestion of hybridity and specimens in herbaria have usually been referred to the latter species. Mr. Bush states that where it grows with *V. prunifolium* it flowers about ten days earlier than that species.

THE MYCENAS OF NORTH CAROLINA

By H. C. BEARDSLEE and W. C. COKER

PLATES 6–30

Plants small, thin, not persisting or reviving well when wet, usually striate, rarely fully expanding but remaining bell-shaped with the margin not incurved. Stem hollow, cartilaginous. Gills adnate or adnexed, usually notched at the stem and decurrent with a tooth. Spores white, smooth in all species here included. In youth the cap margin lies flat against the stem, thus differing from *Collybia*, where it is incurved.

The species of *Mycena* grow mostly on wood and decaying leaves with a few on the ground. They are too small to be of consequence as food, though McIlvaine reports several edible and finds them unusually good. *Mycena splendidipes* Pk. is said to be distinctly poisonous (Bull. N. Y. St. Mus. **167**: 52, pl. 10. 1913). Other species are harmless so far as known.

Curtis records twenty-one species for North Carolina, including the records of Schweinitz. Of these *M. iocephalus* and *M. cohærens* are now treated as *Marasmius*, and *M. elegans*, *M. lactea*, *M. atro-cyanea*, *M. amicta*, and *M. citronella* have not been recognized as American by recent authors. But Curtis' entry of *M. amicta* almost certainly stands for our *M. iris*. *Mycena Adonis* is also considered doubtfully American by Murrill in North American Flora, but we consider it the same as *M. incarnata* Pk. and *M. pulcherrima* Pk. The remaining species in Curtis' list, we are treating under the same names. Atkinson reports four species of *Mycena* from Blowing Rock, one of which, *M. stipularis*, is not included as American by other authors, and we have not been able to confirm the record. *Mycena mucor* we are considering as probably a form of *M. setosa*. *Mycena corticola* and *M. galericulata* we also find. We have found thirty-four species in North Carolina, and are also including several interesting species not yet found in the state which we have detected elsewhere. Four European species have been included which seem not to have been reported before for the United States. Of these *M. gypsea* has been approved by Bresadola, and the others have been studied with especial care. All of these have unusually marked characters; *M. crocata* has a yellow juice; *M. fellea* an intensely bitter taste and unusual cystidia; and *M. erubescens* a milky juice with wounds of the cap becoming carmine. All of these characters were well shown in our specimens, which seemed to leave little doubt as to their identity.

The single specimen described as new has marked characters which we have been unable to find in any described species.

Several other species whose occurrence in America has been considered doubtful have been included only after very careful scrutiny and extended study in the field and laboratory. Among these are: *M. lineata*, *M. filopes*, *M. capillaris*, and *M. debilis*.

The Mycenas are, unfortunately, not well understood at present. Many of the species are very small and inconspicuous, and their minuteness and delicacy render their study more than usually difficult. An added embarrassment is the fact that the European students, upon whom we are forced to depend for an interpretation of their species, often give us incomplete and even contradictory data in regard to them.

On account of these facts the status of some of our American species is unsatisfactory, and a final disposition of them cannot be hoped for until further light has accumulated.

In our studies of the North Carolina species particular attention has been paid to the microscopic structure, and a painstaking attempt has been made to connect our species with those of Europe, using the data which has accumulated during the past few years. Lange, von Hohnel, Ricken, and Rea have been found particularly valuable. Lange, whose careful study of the spores and cystidia of the Danish species has been of much assistance, has been followed in most of the disputed species.

In the study of the Mycenas the following notes may be of value. In collecting the main problem is to get the smaller and more delicate species to the laboratory in satisfactory shape for study and photography. In this difficulty we have found small collecting boxes partly filled with damp sphagnum of great assistance. Each box is limited to one collection, except in the case of species which are so manifestly different that they can be at once separated. It is also good practice to wrap each collection in tissue paper before putting in the boxes.

In the microscopic examination, in addition to the usual examination of the spores, the cystidia and basidia should be carefully studied. Most of the Mycenas have the usual four-spored basidia. A few species will be found to have them consistently two-spored, so that the nature of the basidia must be accurately ascertained. In this determination the method used by Lange will be found satisfactory. A portion of a gill which is not too far advanced is placed on a slide and examined dry without a cover-glass. With moderate magnification (16 or even 4 mm. objective) by focusing up, the groups of spores will be brought into clear view, and will be seen to be in groups of four or two. With a little

practice, if the gill is in the right stage of development, this determination can be easily and accurately made.

A portion of the gill including the margin should also be mounted in water and examined in the usual way. It will be found that in practically all the species the gill margins are set with curious sterile cells, which for convenience we shall call cystidia. These cystidia are of two distinct classes. One set is globose to club-shaped with more or less rod-shaped projections, which give them a prickly appearance. The other set is smooth and varies from slender thread-shaped to conic or lanceolate. In many scores of examinations these have been found to be fairly constant in form, giving valuable criteria for the determination of species. In some species they are conspicuous on the sides as well as the margins of the gills. In fresh material they are easily studied, but are sometimes difficult to demonstrate in dried specimens.

In the classification of species, Fries' division into sections has been followed without change. In identifying any species, care should be taken to determine the section to which it should be referred. In most cases this can be done with certainty. In case of doubt study the entire description of the sections concerned. When the section has been determined it is hoped that the key to it will give the species without too much difficulty.

Under the specific discussions all numbered collections are from Chapel Hill (Coker and students, coll.) unless otherwise noted. Specific descriptions are by Beardslee unless stated to the contrary.

IMPORTANT LITERATURE

(Omitting older works)

von Hohnel: Fragments zur Mycologie Mitteilung XV. No. 794. Sitzungsber. d. K. Akad. Wissensch. Wien, Mathem.-Naturw. Klasse **122,** Abt. 1. 1913.

Kauffman: Agaricaceæ of Michigan, p. 778. 1918.

Lange: Studies in the Agarics of Denmark-I. Dansk Bot. Arkiv **1,** No. 5: 6. 1914.

Murrill: North American Flora **9**: 319. 1916 (as *Galactopus* and *Prunulus*).

Peck: Rept. N. Y. St. Cab. **23**: 80. 1872. Bot. ed.

Rea: British Basidiomycetes, p. 373. 1922.

Ricken: Die Blatterpilze **2**: 418. 1915.

KEY TO THE SECTIONS AND SPECIES

Stem exuding a colored or milky juice when wounded . . . . . LACTIPEDES
Stem not as above, but glutinous when moist . . . . . GLUTINIPEDES

Stem without juice and not glutinous
  Gills with a distinct colored margin . . . . . CALODONTES
  Not as above
    Stem slender, dilated at the base into a bulb or disk . . . . . BASIPEDES
    Stem slender, inserted, i.e., growing from the matrix (leaves or twigs) without any tubercle or rooting portion . . . . . INSITITLÆ
    Not as above
      Cap white or pure colored, not becoming gray or fuscous; gills not changing color . . . . . ADONIDÆ
      Not as above
        Stem slender, filiform . . . . . FILIPEDES
        Stem thicker, rather rigid; gills white, then gray or pink; cap not hygrophanous . . . . . RIGIDIPEDES
        Stem fragile; gills changing color; cap hygrophanous . . . FRAGILIPEDES

I. LACTIPEDES*

Stem and gills exuding a milky or colored juice when wounded. Stem dry, rooting.

Juice white, like milk
  Wounds of the cap becoming red . . . . . M. erubescens (p. 55)
  Wounds of the cap not changing color . . . . . *M. galopus* (p. 56)
Juice yellow or orange . . . . . M. crocata (p. 55)
Juice dark red
  Gills with a distinct, dark margin
    Gills narrow, not decurrent . . . . . *M. sanguinolenta* (p. 57)
    Gills broad, decurrent . . . . . *M. anomala* (p. 58)
  Gills without a dark margin . . . . . *M. haematopa* (p. 56)

II. GLUTINIPEDES

Stem juiceless; glutinous or viscid. Gills at length decurrent with a tooth.

Cap 1–3 cm. broad, yellow to orange or vermilion . . . . . *M. Leajana* (p. 62)
Not as above.
  Cap and stem both viscid
    Cap pure white . . . . . *M. rorida* (p. 60)
    Cap gray to brownish gray, becoming umbilicate . . . *M. vulgaris* (p. 60)
    Cap and stem with more or less yellow . . . . . *M. epipterygia* (p. 61)
  Cap dry, stem viscid . . . . . *M. clavicularis* (p. 59)

III. CALODONTES

Stem juiceless; not expanded at the base into a disk or bulb. Margins of the gills darker (*M. sanguinolenta* and *M. anomala* in Lactipedes also have the gill margins colored, but are distinguished by their bleeding stems).

Caps fleshy, 2–5 cm. broad
  Caps yellow, shading to orange or vermilion . . . . . *M. Leajana* (p. 62)
  Caps livid purple to gray . . . . . *M. pelianthina* (p. 63)

*Species found in North Carolina are put in italics.

Caps much smaller, thin and membranous
Cystidia smooth, awl-shaped . . . . . *M. rubro-marginata* (p. 64)
Cystidia setulose, round club-shaped to globose
Caps livid gray to brownish . . . . . *M. capillaripes* (p. 64)
Caps red to bright red . . . . . M. rosella (p. 65)

IV. BASIPEDES

Stem dry, rootless, dilated at the base into a flat disk or swollen into a small bulb.

Stem dilated into a flat disk . . . . . *M. stylobates* (p. 65)
Base of stem swollen into a small bulb
Plants pure white, caps frosted with minute particles . . *M. tenerrima* (p. 66)
Caps gray, not frosted . . . . . *M. mucor**

V. INSITITIÆ

Stem very slender, inserted, i.e., growing on other plants without a root, tubercle, or flocci at the base. Gills adnate with a small decurrent tooth.

Growing on the bark of trees
Spores nearly globose; cystidia setulose . . . . . *M. corticola* (p. 68)
Spores ellipsoid; cystidia smooth . . . . . *M. hiemalis* (p. 69)
Growing on old leaves
Stem with spreading hairs . . . . . *M. setosa* (p. 69)
Stem glabrous . . . . . *M. capillaris* (p. 70)

VI. ADONIDEÆ

Stem juiceless, not dilated at the base into a disk. Gills not changing color. Cap pure colored, not becoming fuscous or cinereous.

Cap pink to lilac, 1–2 cm. broad, odor of radish . . . . . *M. pura* (p. 70)
Not as above
Cap pure white
Plants solitary; cap 5–10 mm. broad . . . . . *M. minutula* (p. 72)
Plants cespitose; cap 1–2 cm. broad . . . . . *M. gypsea* (p. 73)
Cap somewhat greenish . . . . . *M. lineata* (p. 71)
Not as above
Cap pink, fading to whitish, no trace of yellow . . . . *M. amabillissima* (p. 74)
Cap at first clear cadmium-yellow; stem pale yellow; growing on buried nuts . . . . . *M. luteo-pallens* (p. 75)
Cap pinkish-yellow to reddish-yellow; stem white . . . . *M. Adonis* (p. 75)

VII. FILIPEDES

Stem scarcely 2 mm. thick, flaccid, somewhat tough, rooting, dry, juiceless, commonly very long in proportion to the cap, very slender, tense and straight

*See remarks under *M. setosa*.

terrestrial and among mosses. Cap fuscous (in *M. acicula* orange), becoming somewhat pale, not hygrophanous. Plants solitary, inodorous.

Base of the stem with blue, mycelial fibers . . . . . *M. Iris* (p. 77)
Not as above
  Cap yellow to orange or red . . . . . *M. acicula* (p. 78)
  Cap gray to whitish
    Cap somewhat greenish; cystidia broad, thickly set with small pointed warts . . . . . *M. lineata* (p. 71)
    Not as above
      Taste intensely bitter . . . . . M. fellea (p. 87)
      Not as above
        Cap with a prominent black umbo . . . . . *M. atroalba* (p. 79)
        Not as above
          Cap 2–4 mm. broad; spores 10–12μ long . . . . . M. debilis (p. 80)
          Cap 5–15 mm. broad; spores 8–10μ long . . . . *M. filopes* (p. 80)

VIII. RIGIDIPEDES

Stem firm, rigid, somewhat tough, somewhat strigose and rooted at the base. Gills changing color, white, then gray or reddish, commonly at length connected by veins with age. Cap not hygrophanous. Commonly growing on wood and cespitose.

Cystidia setulose or spinulose
  Plants densely cespitose; stems soon bright bay
    Growing on frondose wood; tomentum white . . . . . *M. inclinata* (p. 81)
    Growing on pine; tomentum tawny . . . . . *M. intertexta* (p. 82)
  Not as above . . . . . *M. galericulata* (p. 84)
Cystidia smooth
  Stem 7–10 cm. long, longitudinally striate . . . . . M. polygramma (p. 86)
  Stem shorter; caps soon nearly plane . . . . . *M. excisa* (p. 87)

IX. FRAGILIPEDES*

Stem dry, juiceless, scarcely rooting, but not dilated or inserted at the base. Gills changing color, at length venous connected. Plants hygrophanous, rather tender and fragile; commonly strong scented; normally solitary and terrestrial; a few cespitose species and growing on wood.

Taste intensely bitter . . . . . M. fellea (p. 87)
Not as above
  Cespitose on wood . . . . . *M. alkalina* (p. 88)
  Not as above
    Caps ashy gray or canescent, sulcate-striate . . . . . *M. leptocephala* (p. 89)
    Cap grayish brown to grayish umber, striatulate . . . M. ammoniaca (p. 89)

*The species of this group have been identified with some misgivings. In addition to *M. fellea*, which seems especially well marked, three species have been found which clearly belong to this section. All have an alkaline odor of varying intensity, and grayish gills. One species, which grows in clusters on old logs, and has a slippery stem and narrowly acuminate cystidia has been referred to *M. alkalina*, which is said by all European authorities to agree in its slippery stem and whose cystidia as shown by Lange and von Hohnel are like those of our plant. The second is marked by an ashy gray cap which is sulcate-striate and at times pruinose and has been referred to *M. leptocephala* which is said to have these characters. A third species, growing solitary on the ground, has been considered *M. ammoniaca*. Until authentic material is at hand for comparison these determinations cannot be considered final.

Mycena crocata Schrad.

Cap 1–2 cm. broad, campanulate, becoming expanded, olive-yellow to grayish yellow, glabrous, striate when moist.

Gills adnate, white, becoming yellowish, somewhat ventricose, not crowded.

Stem 5–8 cm. long, about 2 mm. thick, colored like the cap but lighter, glabrous, rooting; when cut exuding a yellow or orange juice (close to the color of *Chelidonium*).

This species has been found only once and its cystidia and spores were not studied. It is clearly different from our other species which belong to this section in its colors and peculiar juice. In appearance it was very similar to Cooke's figure of *M. chelidonia*, which Lange considers a form of this species.

Illustrations: Cooke. Ills. Brit. Fungi, pl. 163, fig. 2.
Juillard-Hartmann. Icon. Champ., pl. 36, fig. 5.
Maine: Harpswell. In leaves and moss.

Mycena erubescens von Hohnel

PLATES 8 AND 29

Cap 3–8 mm. broad, conic-campanulate, becoming broadly campanulate with age, dull and opaque in appearance, somewhat hygrophanous, yellow-brown, shading to deep brown at the center when moist, pale gray-brown with the center darker when dry, margin incurved and almost fluted when young, striate almost to the center with age, glabrous, thin and membranous. No odor or taste.

Gills narrow, not ventricose, somewhat distant, adnate, white, becoming grayish with age, margin minutely flocculose.

Stem 5–7 cm. long, scarcely 2 mm. thick, glabrous, colored like the cap below, paler above, attached by white mycelial fibers to old leaves, etc. Wounds of the cap and stem exude a copious milky juice and soon become stained red.

Spores ellipsoid, 4–4.5×6–7μ. Cystidia numerous, 7–12μ thick at the gills, extending 30–40μ to a slender point. Basidia 4-spored.

This is smaller than von Hohnel's species is described and has somewhat different spores, but it seems too close for separation from his species, of which it seems the American representative. It is unusual in its milky juice and in the red color which is soon assumed when the cap is cut. So far it has been detected in only one station.

Ohio: Painesville. On old leaves.

Mycena galopus Pers.

PLATES 9 AND 29

Cap 8–15 mm. broad, at first rounded campanulate, becoming expanded with the center somewhat prominent, cinereous to fuscous at the center, fading to grayish white at the margin, distinctly striate nearly to the center which is slightly fleshy with the margin thin and membranous.

Gills white, not crowded, attenuate behind and adnexed.

Stem 4–6 cm. long, 2 mm. thick, colored like the cap at the base, paler above and white at the apex, glabrous above, white strigose at the rooting base.

Spores 4–5×9–11μ, ellipsoid. Cystidia abundant, blunt awl-shaped. Basidia not studied, said to be 4-spored.

Both gills and stem exude an abundant white juice when wounded.

This species seems to be southern in its distribution. I have found one reference to it in Peck; Kauffman does not list it from Michigan; and Murrill excludes it from North American Flora. At Asheville during the summer it is one of our commonest species. Our plants were identical with *M. galopus* as we found it in Sweden, and the abundant milky juice which exudes from its wounds would seem to leave no room for doubt. No species of *Mycena* is recognized with greater certainty when seen in the living state, though, as usual in *Mycena*, herbarium material is unsatisfactory. The dark form, *M. leucogala*, which is found with the typical form in Europe, was not observed at Asheville.

Illustrations: Cooke. Ills. Brit. Fungi, pl. 207 B.
Gillet. Champignons, pl. 463.
Ricken. Die Blatterpilze **2**: pl. 109, fig. 11.

Asheville. On old leaves in woods. Common.

Mycena hæmatopa Pers.

PLATES 6 AND 29

The following is by Coker:

Cap 1–3 cm. broad, minutely pruinose, conic, becoming expanded and somewhat umbonate, grayish to dull flesh color or purplish gray, darker and dull reddish brown at the center. Flesh very thin except at the center, colored like the surface, tasteless and odorless, yielding a dark red juice when cut.

Gills whitish, then flesh color, sometimes red spotted, rather narrow, not crowded, adnate, becoming deep reddish when bruised.

PLATE 6

MYCENA HÆMATOPA
Photo by B

Stem 4–8 cm. long, 1.5–3 mm. thick, colored like the cap, minutely downy when young, becoming glabrous with age, yielding a dark red juice when wounded; a small clean hollow in center.

Spores 5.5–7×8–10μ, elliptic. Cystidia extending 35–45μ beyond the gills in a long, tapering point, inflated below, 12–14μ thick. Basidia 4-spored.

Growing in clusters on old logs. Common.

This species seems to be widely distributed. Everywhere it is found in dense clusters on old logs and is at once recognized by the dark red juice which exudes from its wounds. We find the young plants with a dull, opaque appearance, due to the very minute downiness which is apparent only under a lens. The denticulate margin of the cap is unusual and quite striking.

Illustrations: Atkinson. Stud. Am. Fungi, fig. 100.
Cooke. Ills. Brit. Fungi, pl. 162 A.
Fries. Icon. Selectæ, pl. 83, fig. 1.
Hard. Mushrooms, fig. 90.
Marshall. Mushroom Book, pl. 37.
White. Conn. State Geol. and Nat. Hist. Survey Bull. 15: pl. 10. 1910.

1898. On a rotten trunk of a deciduous tree, Oct. 17, 1915. Spores cream color in bulk, 6–7.2×7.2–10.8μ.

2447a. On a rotten log, fall of 1916. Spores about 6×8μ.

3505. On a decaying log, Oct. 25, 1919.

Asheville. Common.

Mycena sanguinolenta A. & S.

PLATES 7 AND 29

Cap 1.5–1.9 cm. broad, campanulate, smooth, striate on the margin, umbonate, not viscid, color a dull reddish ochraceous in the center, fading to a paler dull ochraceous at the margin, and much spotted and striated with this paler color over most of the surface. Flesh about 8 mm. thick at the center, firm and not very brittle, dull brownish with a yellowish tint and decidedly yellow in places; odor decided and peculiar, rather like the cold fire-box of an engine (nitrous).

Gills rather distant, 2–2.5 mm. broad, broadly adnate and slightly decurrent by a tooth; color a pale creamy pink at maturity, turning to yellowish in age, the edges deep purplish to blackish red.

Stem 5–7.5 cm. long, about 1.5 mm. thick, nearly equal, translucent, yellow, with minute reddish dots above, brownish ochraceous and short

fibrous below; flesh color of surface, yielding a milk of its own color when broken, a large clean hollow in the center.

Spores white, elliptic, smooth, 5×8–10μ. Cystidia plentiful, enlarged below, up to 12μ thick, contracted abruptly to a point which is often long and curved.

These plants are like Peck's New York specimens in being umbonate and at times cespitose. He says (Rept. N. Y. St. Mus. **23**: 84. 1873): "All my specimens have the pileus umbonate and were cespitose, in which particulars they do not agree with the published descriptions, still I am unwilling to make a new species on such slight differences." Neither Peck nor others mention the nitrous smell of our plant.

Coker's description, which is given above, covers this species as I have found it at Asheville. It may be added that the basidia in my specimens have been 4-spored, and the dark cystidia which are found in a crowded zone on the margin and thinly scattered on the sides toward the margin are taper-pointed, with the base inflated. They extend 12–25μ beyond the gills and are 8–12μ at the gill.

In addition to the fine robust form which is well shown in the photo, I find also a much smaller and thinner form on hemlock cones, etc., which from its gross characters might almost be considered distinct. There is, however, no difference in microscopic structure and I have considered it only a small form of the species. Specimens of *M. sanguinolenta* found and studied in Sweden differed in no way from our plants.

Illustrations: Cooke. Ills. Brit. Fungi, pl. 163, fig. 1.
Fries. Icon. Selectæ, pl. 83, fig. 3.
Juillard-Hartmann. Icon. Champ. Sup., pl. 37, fig. 13.
Ricken. Die Blatterpilze **2**: pl. 110, fig. 7.

1916. Gregarious and occasionally cespitose in beech leaves, Oct. 12, 1915.

3550. In a sandy flat with leaves, Oct. 29, 1919.

4321. In mossy humus by a brook, June 23, 1920.

5696. On very rotten wood, Aug. 12, 1922.

Asheville. Occasional.

Blowing Rock. On very rotten wood, Aug. 22, 1922 (Coker).

Mycena anomala Beardslee, n. sp.

PLATE 29

Cap 4–8 mm. broad, thin and membranous, at first campanulate, becoming expanded and plane or even depressed with age, sulcate-

PLATE 7

MYCENA SANGUINOLENTA. No. 1916

Photo by C

striate with forking furrows, mahogany-red to brownish red, very minutely downy.

Gills distant, few in number, broad, almost triangular, adnate decurrent, colored like the cap, margin darker, deep red-brown.

Stem slender, 4–6 cm. long, scarcely 1 mm. thick, pale, but with a slight red tint, very minutely downy, attached by a circle of fibers to pine needles at the base, exuding a dark red juice when wounded.

Spores narrowly ellipsoid, 4×11–12μ. Cystidia abundant on the margins of the gills, globose to rounded obovate with pointed, rod-like projections.

This interesting species was found once growing in abundance on the fallen needles under pines. Unfortunately, the photograph which was made was not successful and there was no other opportunity to make one. The drawing made at the time will show its peculiarities and it will be readily recognized by its unusual characters. In many ways this species is suggestive of *Omphalia*. The broad gills which seem quite decurrent as the cap becomes expanded would almost indicate its reference to that genus. In its bleeding stem, margined gills, and setulose cystidia it finds, however, close relatives in *Mycena* and it has seemed best to place it with these and ignore the somewhat decurrent gills.

Asheville. Under pines, Sept. 9, 1918.

Mycena clavicularis Fr.

PLATE 9

Cap 3–15 mm. broad, campanulate, becoming expanded and depressed at the center, pale whitish to yellow or grayish yellow, sulcate-striate, dry, glabrous.

Gills white or yellowish, adnate or somewhat decurrent, close.

Stem 4–6 cm. long, slender, white or pale yellow, viscid when moist, but soon becoming dry and shining.

Spores 4–5×7–9μ. Cystidia and basidia not studied.

As I have found it this species varies in color. The viscidity of the stem is slight and soon disappears.

Illustrations: Cooke. Ills. Brit. Fungi, pl. 208B.
Fries. Icon. Selectæ, pl. 84, fig. 1.

Asheville. On pine needles, etc., Aug. 15, 1914.

Mycena rorida Fr.

PLATE 10

Cap 5–12 mm. broad, white, often with a little yellow when wet, becoming pure white when dry, thin and membranous, convex, becoming expanded and depressed or umbilicate, rugulose when moist, glandular pubescent.

Gills white, narrow, not crowded, arcuate-decurrent, flocculose on the margin, forking and unequal, venous connected.

Stem slender, 2–5 cm. long, white, glandular pubescent, in wet weather covered with a thick layer of hyaline gluten which is quite conspicuous.

Spores 4–5×8–11μ. Cystidia abundant in a sterile zone at the margin of the gills, narrow club-shaped, 6–10μ thick, extending as much as 25μ beyond the margin.

This species needs further study and careful comparison with European material which is not at present at hand. I am placing it here in the conviction that it is at least close to *M. rorida*. It is probably also *Marasmius resinosus* Peck, though the spores of our plants, which have been repeatedly measured, are larger than the dimensions given by Kauffman and Pennington.

The most striking character of our plant is the thick layer of hyaline gluten which covers the stem in wet weather. In dry weather this disappears, and in drying the stem becomes shining and glassy in appearance. The cystidia of our plants are not as large as Lange describes them, being rather slender club-shaped than conical. They are abundant and in dried specimens become yellow, forming a distinct darker zone on the margin of the gills. In the photo of this species the group at the right shows plants with the stem covered with the characteristic gluten. Those to the left show the gluten dried and not conspicuous.

Illustrations: Cooke. Ills. Brit. Fungi, pl. 248 (lower figs.).
Juillard-Hartmann. Icon. Champ. Sup., pl. 38, fig. 5.

Asheville. On old sticks, etc.

Mycena vulgaris Fr.

Cap 6–10 mm. broad, rounded campanulate, becoming expanded and nearly plane with a shallow depression at the center, pale gray or isabelline gray with the center darker, rugose striate when moist, cuticle separable.

PLATE 8

MYCENA PURA (upper left); No. 3180 (below)
MYCENA ERUBESCENS (upper right)
Upper photos by B; lower by C

PLATE 9

MYCENA CLAVICULARIS (above)
MYCENA GALOPUS (below)

Photos by B

Gills white, not crowded, usually quarternate, venous connected behind, decurrent.

Stem colored like the cap, rather tough, glutinous in wet weather.

Spores 4–5×8.5–10μ. Basidia 4-spored.

In many ways this seems to belong to *Omphalia*. The gills are unquestionably decurrent, and the cap is umbilicate.

Illustrations: Atkinson. Stud. Amer. Fungi, fig. 97.
Cooke. Ills. Brit. Fungi, pl. 191B.
Gillet. Champignons, pl. 461 (150).
Juillard-Hartmann. Icon. Champ. Sup., pl. 37, fig. 17.
Ricken. Die Blatterpilze **2**: pl. 109, fig. 8.

7353. In a colony on pine needles, July 9, 1924. Spores ovate, 3.8–4.5×7–8μ.

Asheville. Growing in colonies on pine needles, etc.

Mycena epipterygia Fr.

PLATE 11

Cap 5–15 mm. broad, rounded campanulate, becoming expanded, pallid, yellow, cinereous or brown, striate, viscid with a separable, gelatinous cuticle, thin and membranous.

Gills whitish, becoming flesh color with age, adnate to slightly decurrent, rather broad, ventricose.

Stem slender, 5–8 cm.×1–2 mm., yellow to grayish, viscid, white strigose at the base.

Spores 5–6×7–9μ. Basidia and cystidia not studied.

The viscidity and yellow color distinguish this species. It seems widely distributed.

Coker's notes follow:

Cap up to 1.2 cm. (rarely 2.8 cm.) broad, when young nearly spherical or sub-conic, the margin bent in and clasping the stem by a little frill which is broken up in expanding to form small, appendiculate fragments on the margin; cap at maturity broadly campanulate and striate to near the center, in youth not striate; surface viscid, pruinose, varying from dark blackish brown to lighter brown with a touch of chocolate or yellow, the margin greenish yellow or brownish yellow, cuticle very tough, the flesh beneath tender, greenish yellow, thin; taste peculiar, somewhat like a vegetable but rank (not bitter or acrid).

Gills rather distant, broadly adnate and decurrent by a tooth, about 2–2.5 mm. wide, color of the flesh except the minutely granular margin, which is abruptly whitish with a faint tint of pink; at maturity the yellow fading and the whole becoming pallid flesh color.

Stem long and slender, up to 7 cm. long and 1.8 mm. thick, flexuose, viscid, minutely granular all over when young, light greenish yellow at all ages or fading to brownish in age, when bruised turning deep reddish brown, a minute hollow in center, the base wrapped in delicate white cotton.

Spores (of No. 2966) smooth, elliptic, 5.5–6.8×10–11.8μ. Basidia (of H. No. 74) 4-spored.

This is certainly close to *M. citronella* which differs (according to Massee's description and Cooke's plate) in its lighter cap and white gills.

Illustrations: Atkinson. Stud. Amer. Fungi, fig. 96.
Cooke. Ills. Brit. Fungi, pl. 208 A.
Gillet. Champignons, pl. 461 (149).
Hard. Mushrooms, fig. 96.
Ricken. Die Blatterpilze **2**: pl. 109, fig. 12.

2966. At foot of a living pine, Dec. 5, 1917.

2967. On a decaying pine log, Dec. 5, 1917.

2976. On ground near a decaying pine stump, Dec. 3, 1917.

2978. At foot of a pine stump, Dec. 7, 1917. Cap deep blackish brown, then lighter brown, up to 2.8 cm. broad.

3891. In damp humus, Dec. 13, 1919.

4780. On bark at base of a pine tree, Jan. 17, 1921. Caps olivaceous yellow in youth, becoming grayish tan with yellowish margin. Spores oval, smooth, 6.5–7.5×9–11μ.

Asheville. In pine needles and on old logs.

South Carolina: Hartsville. Coker, No. 74. On a rotting pine stump with *Omphalia campanella*, Dec. 26, 1918. Spores 6.6–8.1×9.3–13.3μ.

Mycena Leajana Berk.

PLATES 12 AND 29

Cap 2–5 cm. broad, round-convex, becoming expanded and often depressed at the center, bright orange to vermilion in the young plant, fading to pale yellow with age, viscid when moist, cuticle tough, separable and adorned with agglutinate red fibrils.

Gills colored like the cap with the margin deep orange-red, rather close, adnate.

Stem tough, colored like the cap, equal, usually curved, viscid, with abundant fibers at the base.

Spores ovate-ellipsoid, 4–5×7–8μ. Cystidia abundant on the gill margins, forming a wide sterile zone, free portion conical, 20–30μ long 10–14μ thick at the gill. Basidia 4-spored.

PLATE 10

MYCENA CORTICOLA (above)
MYCENA RORIDA (below)
Photos by B

PLATE 11

MYCENA EPIPTERYGIA. No. 2966

Photo by C

Under the microscope the margin of the gills is very striking. The bright color of the abundant cystidia contrasts strongly with the remainder of the gills. On the sides of the gills the cystidia are present but less abundant than on the margin. The entire plant is clothed with a sticky gluten which stains the fingers in collecting it. This is one of our most vivid and conspicuous species. Its clustered habit of growth and bright colors at once distinguish it.

Illustrations: Hard. Mushrooms, fig. 94.
White. Conn. State Geol. & Nat. Hist. Survey Bull **15**: pl. 11. 1910.
Asheville. In dense clusters on old logs.

Mycena pelianthina Fr.

PLATES 13 AND 29

Cap 2–5 cm. broad, somewhat fleshy, rounded convex, becoming expanded, obtuse, hygrophanous, purple-livid to brownish gray when moist, paler when dry, fleshy at the center, thin and striate on the margin.

Gills moderately broad, not crowded, sinuate-adnexed, dull purple-brown when moist, margin dark purple.

Stem 5–7 cm. long, 3–8 mm. thick, colored like the cap, glabrous, hollow, fibrous.

Spores 3–4×6–7.5μ, ellipsoid. Cystidia abundant on the sides and margins of the gills, large and coarse, conical to almost cylindrical, 12–18μ thick, extending 40–50μ. Basidia 4-spored.

In many ways this species is unusual. In appearance it is suggestive of *Collybia*. Its cap is slightly fleshy and lacks entirely the campanulate shape which is so common in *Mycena*. The gills are suggestive of *Psalliota*. Its comparatively large size, sordid purplish color and margined gills will at once distinguish it. It seems to occur everywhere.

Coker's notes follow:

Cap 2.2–3.8 cm. broad, convex, usually gibbous with a slight depression in the center, smooth and a little viscid, dull ochraceous in center, paler towards margin, the whole with a very faint pruinosity which is lilac; margin not striate. Flesh toughish, concolorous; taste and odor strong of a rank vegetable like raw potatoes or peanuts.

Gills 4.5 mm. wide, not much crowded, ventricose, usually notched at stem and broadly adnate, easily separable; color dull cinnamon-buff, the margin obviously lilac and the sides very faintly so.

Stem about 3–4 cm. long, 3–4 mm. thick, nearly equal, smooth, shining, distinctly striate and often twisted, quite hollow, toughish, succulent.

Spores (of No. 3544) white, smooth, elliptic, mostly pointed at one end, 2.2–3.2×5.5–7.4μ. Cystidia (of No. 5135) long, pointed, ten-pin-shaped. Basidia with 4 long sterigmata.

The lilac pruinosity extends in faint lines across the cap apex. It would scarcely be noticed without a lens.

Illustrations: Boudier. Icones Myc. **1**: pl. 67.
Cooke. Ills. Brit. Fungi, pl. 156, fig. 1.
Gillet. Champignons, pl. 466.
Ricken. Die Blatterpilze **2**: pl. 110, fig. 3.

3544. Deciduous woods, Oct. 27, 1919.

5135. In damp leaf-mold, May 20, 1922. Spores 3.2–3.6×6.5–8μ, pointed at one end.

Mycena rubromarginata Fr.

PLATES 12 AND 29

Cap 10–15 mm. broad, campanulate, obtuse, dull lilac-purple to brownish purple, hygrophanous, thin and membranous, striate, glabrous.

Gills white or whitish, deep brownish purple on the margin, adnate with a decurrent tooth, narrow, distant.

Stem 3–5 cm. long, about 1.5 mm. thick, colored like the cap but paler, glabrous, but attached to the matrix by abundant white fibers.

Spores varying from nearly globose, 7–7.5μ broad, to ellipsoid, 7–8×9–11μ. Cystidia blunt awl-shaped, about 5–6μ thick, not extending far beyond the margin of the gills. Basidia 4-spored.

This seems also *M. purpureofusca* Pk., but I cannot find sufficient difference to separate it from the European species. My plants were hygrophanous, though Peck's species is said not to be. In small and thin species, however, this character must be used with caution.

The cystidia in my specimens are not as slender as Lange finds them, but they agree with specimens collected in Sweden and referred to this species with Romell's approval. Whether we have a different species in *M. purpureofusca*, further study will tell.

Illustrations: Cooke. Ills. Brit. Fungi, pl. 284B.
Fries. Icon. Selectæ, pl. 78, fig. 4.

Asheville. Among mosses and old leaves in dense woods.

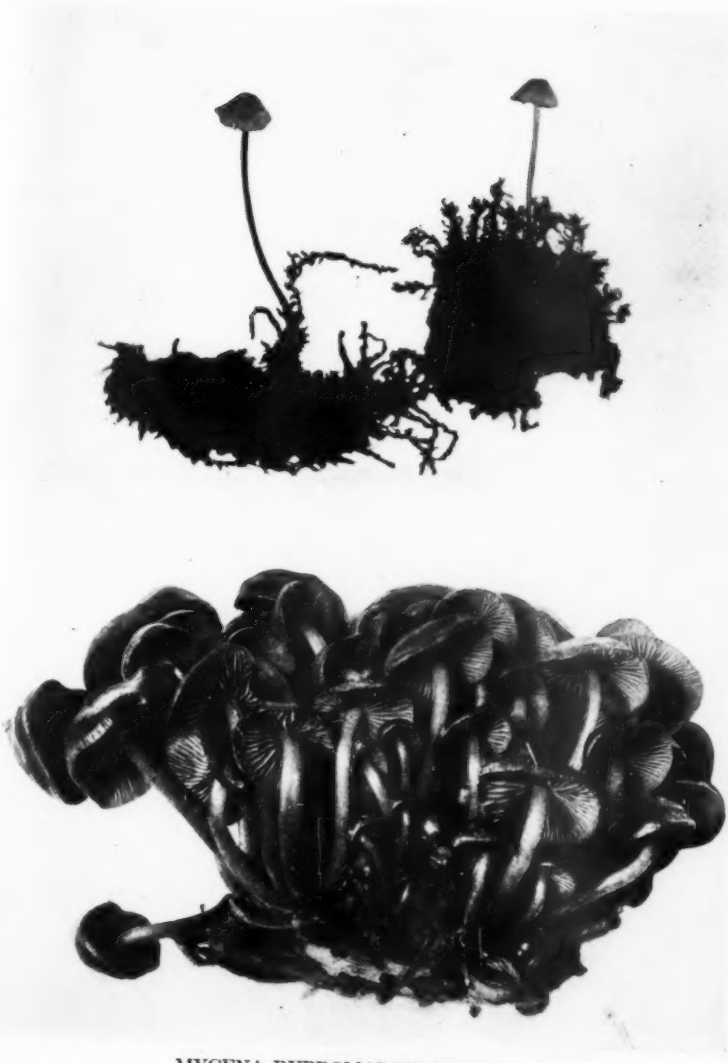
Mycena capillaripes Pk.

PLATES 14 AND 29

The original description is as follows (Rept. N. Y. St. Mus. **41**: 63. 1888):

"Pileus membranous, campanulate, glabrous, hygrophanous, livid

PLATE 12



MYCENA RUBROMARGINATA (above)
MYCENA LEAJANA (below)

Photos by B

gray or brownish and striatulate when moist, paler when dry, odor weak, alkaline; lamellæ ascending, subdistant, adnate, whitish, or livid white, the edge obscurely brownish purple; stem slender, almost capillary, fragile, glabrous, hollow, colored like the pileus; spores narrowly ellipsoid, 7.5×4μ. Pileus 3–5 lines broad, stem 1.5–2 in. long, scarcely 0.5 lines thick. Under pine trees, Karner, August.

"This species is related to *M. rubromarginata*, from which I have separated it on account of its smaller size, slender stem, paler color and smaller spores and alkaline odor. It is also much smaller and paler than *M. purpureofusca*."

Our plants are exactly as Peck describes them, except that I find the spores slightly larger. The cap is hygrophanous, and close to Ridgway's snuff-brown when moist, and pinkish buff when dry. The margin in my plants was sulcate-striate nearly to the center with age. I find the spores 4–5×8–10μ. The margins of the gills are set with rounded obovate cystidia, sometimes extended in a point, and with rod-like processes. The basidia are 4-spored. The margin of the gills is well characterized by Peck as "obscurely brownish purple." The colored margin can easily be overlooked. It is slight and in old specimens can hardly be distinguished.

Asheville. On the ground, under pines.

Mycena rosella Fr.

Specimens of what seems to be this species have been received from Miss Hibbard. They are distinctly different from the other species listed in their bright color and broadly ovate to globose, setulose cystidia. It is hoped that the plant may be found again and carefully studied when fresh. At present it is included in the hope that it may occur in the state and that this note may lead to its collection and study. Compare Kauffman, l.c., p. 791; Ricken, Die Blatterpilze **2**: 422, pl. 109, fig. 5.

Mycena stylobates Pers.

PLATES 15, 16, AND 29

Cap 4–8 mm. broad, round-campanulate, becoming expanded and almost plane, pale gray to almost white, striate nearly to the center, thin and membranous, sprinkled with scattered hairs.

Gills white, free or nearly so, ventricose, distant, alternating long and short.

Stem 2–4 cm. long, filiform, glabrous above, fibrillose toward the

base which is seated on a flat disk, 2–3 mm. broad, which is radiately striate, and fringed with a row of delicate bristles.

Spores ellipsoid, 3.5–4×9–11μ. Cystidia short, slenderly oblong. Basidia 4-spored.

This is one of our most striking and distinct species. The curious disk at the base of the stem is unique and at once marks the species. Our plants have been uniformly white or gray, which agrees with Rea. Ricken finds also a bluish form, which so far we have not detected. The cystidia and spores of our plant agree with Lange's description, though some specimens found at Asheville gave smaller spores, 3–3.5×6–7μ, which are Ricken's measurements. Rea gives them smaller still, 2×4μ, which is much smaller than any we have seen. Murrill excludes this from North American Flora as a doubtful species. It is evident, however that we have a distinct and well marked species, which is either *M. stylobates* or a new species closely allied to it. At present our plant seems too close to *M. stylobates* to admit of the establishment of a new species.

Illustrations: Cooke. Ills. Brit. Fungi, pl. 249, fig. A.
Juillard-Hartmann. Icon. Champ. Sup., pl. 37, fig. 16.

Asheville. On old leaves and sticks; not rare.

Mycena tenerrima Berk.

PLATES 15, 16, AND 29

Cap 1–7 mm. broad, narrow, conic-campanulate, becoming expanded and broadly campanulate, pure white, sometimes slightly yellowish with age, very thin and membranous, appearing glabrous, but under a lens seen to be delicately frosted with shining white particles, striate nearly to the center.

Gills pure white, distant, slightly broader at the center, rather narrow, attenuate-free.

Stem 1–4 cm. long, very thin and delicate, flaccid, pure white, usually with scattered hairs, at times more densely pilose, arising from a small pubescent bulb.

Spores ellipsoid, 4–5×7–9μ. Cystidia inconspicuous, club-shaped, spinulose. Basidia 4-spored. Surface of the cap with spinulose branching filaments, bearing round, oval or rounded polygonal conidia-like bodies which are spinulose and as much as 40μ in diameter. The hairs of the stem are also spinulose and often swollen at the base.

This interesting species seems not rare, though possibly on account

PLATE 13

MYCENA PELIANTHINA. No. 3544

Photo by C

PLATE 14

MYCENA CAPILLARIPES (above)
MYCENA ATROALBA (below)

Photos by B

of its minuteness it has been largely overlooked. Murrill quotes it only from New York State. At Asheville it was found regularly each summer during wet weather. I have found it also in Maine, Ohio, and Florida, indicating a wide distribution.

It is easily one of our most distinct species. Its white color, small size, and the delicate frosting which is apparent under a lens will at once distinguish it. As indicated above the surface of the cap is an interesting object under the microscope. The curious spinulose filaments and rounded bodies are unlike anything in *Mycena* and make it possible to identify the species with reasonable certainty from very fragmentary material. Lange describes the microscopic structure exactly as I find it. Otherwise I find no reference to this unusual character. There seems to be some variation in spores. Ricken says, "Toward winter the spores become round." Our Maine specimens had spores 4–5×5–6μ, but otherwise were typical.

Coker's notes follow:

Entire plant pure white and very delicate and ephemeral, but not very brittle. Cap 4–7 mm. broad, cylindrical and decidedly mealy-scurfy when young, smooth or nearly so and broadly campanulate at maturity, striate to near center. Flesh membranous, odorless, and tasteless.

Gills distant and rather narrow, pure white.

Stems very long and slender, pliable, tapering upward, nearly smooth above, more and more hairy-scurfy and ending in an abruptly enlarged little scurfy boot about 1 mm. long which when very young can be seen to have a fringed margin where the cap edge was torn away. Hairs on stem closely set with minute little spines exactly as the cells on the cap. The stem is attached to the deeper layers of leaves and makes its way up in a crooked fashion through the superficial loose layers.

Spores (of Hartsville, No. 22) smooth, elliptic, a small eccentric mucro, one large or several small oil-drops, 3.7–4.4×4.8–7.7μ.

Easily recognized by its white color and scurfy cap and stem. Bulliard's fig. 2, pl. 601, referred to by Fries, is like our plant, but does not show the scurfy character in youth. This character is also not mentioned by Fries or by Massee. As it is obvious only under a lens it might have been overlooked in the European plant. According to Lange's description, our plant is more like his var. *carpophila* than like the typical form. The spores are nearer the same size and the basidia

are said to be 4-spored. He gives the basidia of the typical form as 2-spored.

Illustrations: Cooke. Ills. Brit. Fungi, pl. 249B.

Lange. l.c., pl. 1, fig. h (as var. *carpophila*).

3295. Under pines, Battle's Park, June 6, 1919. Spores 3.7–4.8×6.6–7.7μ.

3518. On damp decaying leaves, Oct. 26, 1919. Spores 4–5×7.5–10μ, sprouting overnight in a damp chamber into an abundant mycelium of long, delicate threads.

5323. On rotten wood and twigs, July 9, 1922. Spores 3.8–5.5 × 7–9μ.

Asheville. Common.

South Carolina: Hartsville. Coker, No. 22. Attached to leaves of both deciduous trees (oak) and pine, and also on rotting pine cones, June 5, 1917. Apparently dependent on the presence of pine.

Mycena corticola Schum.

PLATES 10 AND 29

Cap 3–8 mm. broad, rounded campanulate to hemispherical, obtuse, sometimes depressed at the center and slightly umbilicate, pale gray, cinereous, brown, or brownish gray, at first delicately pruinose, sulcate-striate, thin and membranous.

Gills rather broad, sometimes ventricose, adnate with a decurrent tooth, colored like the cap but paler, distant, 7–10 of full length.

Stem 6–12 mm. long, slender, colored like the cap but paler at the top, and covered at first with the same pruinosity.

Spores nearly globose, 9–11μ in diameter. Cystidia on margins and sides of the gills, round-obovate, set with pointed processes. Basidia 4-spored.

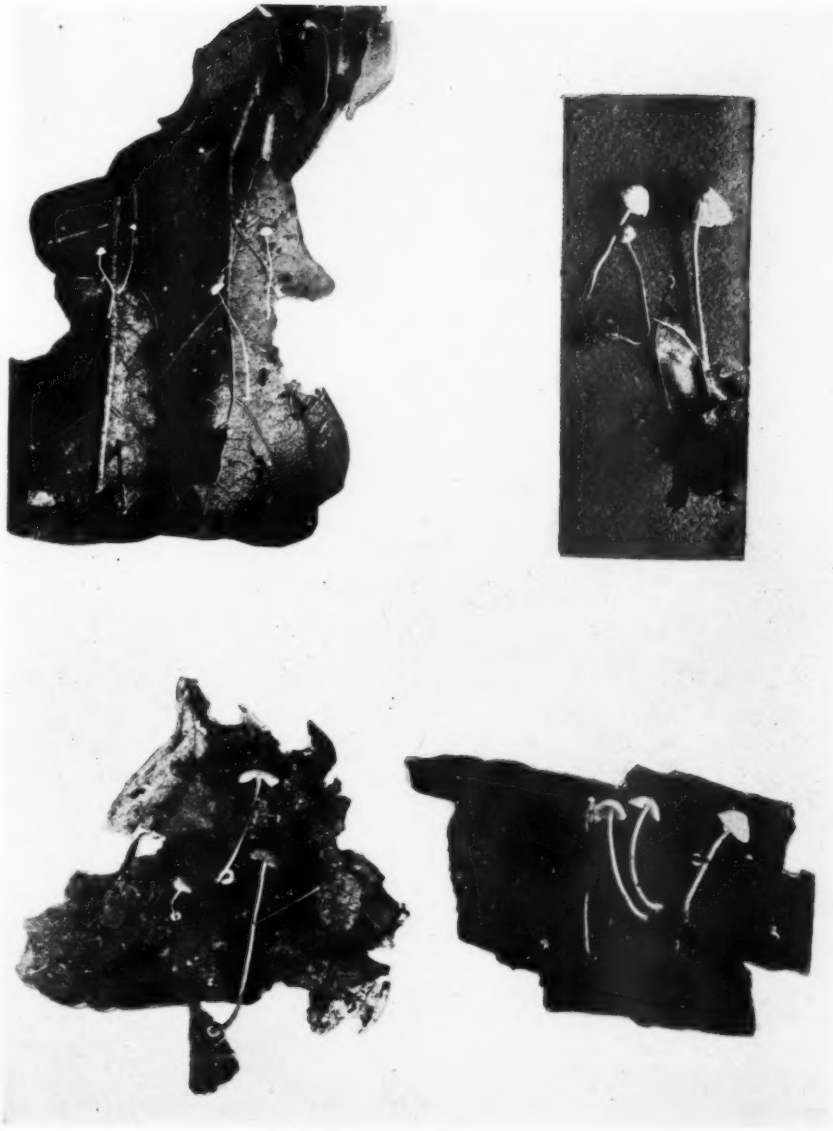
Readily recognized by its small size and its habit of growing in colonies on bark of living trees. It revives perfectly after drying when wet and might well be considered a *Marasmius*.

Coker's notes follow:

Very small and growing singly in rather large colonies on bark of living hardwoods; reviving perfectly when wet as in *Marasmius*. Cap 2.5–3 mm. broad, convex, light fawn-brown or ash-brown, broadly sulcate, inherently granular fibrous, the margin minutely fimbriate. Flesh thin, concolorous, odorless and tasteless.

Gills few (about 7 of full length and a few short ones), distant, thick, squarely adnate, in some attached to a partial ring, concolorous or paler, minutely granular.

PLATE 15



MYCENA TENERRIMA (upper left)
MYCENA LINEATA (upper right)
MYCENA STYLOBATES (lower left)
MYCENA MINUTULA (lower right). First published in Mycologia 9: pl. 4. 1917.

Photos by B

PLATE 16

MYCENA STYLOBATES (above)
MYCENA TENERRIMA (below, left)
MYCENA ADONIS (below, right)

Photos by B

Stem slender, curved, only about 2–3 mm. long, minutely furfuraceous below, granular above.

Spores (of No. 4906) smooth, subspherical, with a small mucro and a large oil-drop, 7.4–10×7.7–11μ. Basidia 4-spored.

Illustrations: Cooke. Ills. Brit. Fungi, pl. 164 (upper figs.).
Fries. Icon. Selectæ, pl. 85, fig. 2.
Gillet. Champignons, pl. 458 (152).
Hard. Mushrooms, fig. 93.

4906. On bark of a living ash tree, about 5 feet from the ground, Nov. 1, 1921.

5927. On bark of a living elm, Dec. 8, 1922. Spores pure white, spherical, 7.8–11μ thick.

7366. On hardwood twig, July 10, 1924. Spores spherical, 9–10μ thick. Cystidia blunt, club-shaped, up to 14μ thick.

Asheville. On bark of living trees.

Mycena hiemalis Fr. PLATES 23 AND 29

Cap 3–8 mm. broad, round-campanulate, often with a distinct umbo, becoming sulcate-striate, gray-brown to cinereous, minutely pruinose, very thin and membranous, margin denticulate.

Gills colored like the cap but much paler, rather broad, adnate with a decurrent tooth, distant.

Stem 5–12 mm. long, very slender, brown with the apex paler, distinctly pruinose under a lens.

Spores ellipsoid, 5–6×8–9μ. Cystidia abundant on the margins of the gills, blunt, awl-shaped, smooth. Basidia 4-spored.

This species seems clearly distinct from *M. corticola* which it resembles in gross characters, in its spores and cystidia. One collection had most of the caps sharply umbonate. Our plants differ from the European descriptions in the broader gills and 4-spored basidia, but it has been thought best to consider them a form of this species.

Illustrations: Cooke. Ills. Brit. Fungi, pl. 164 (lower figs.).
Fries. Icon. Selectæ, pl. 85, fig. 1.
Gillet. Champignons, pl. 458 (153).

7396. On oak bark, July 11, 1924. Spores 4–4.8×7.5–9.3μ. Basidia 4-spored, 7.5μ thick.

Asheville. In colonies on the bark of living trees.

Mycena setosa (Sow.) Fr. PLATE 29

Caps minute, 3–5 mm. broad, campanulate, pale gray to almost white, very thin, striate almost to the center, dry, glabrous.

Gills distant, white, narrow, adnate.

Stem 3–5 cm. long, very slender, pilose.

Spores ellipsoid, 3.5–4×7.5–9μ. Cystidia round-obovate with sharp-pointed projections. Basidia 4-spored.

Some specimens had the caps grayish canescent. Plants found farther south had a distinct, though minute, pubescent bulb at the base of the stem. These would probably be referable to *M. mucor*. I could, however, find no distinction save the slight bulb and prefer to consider them only forms of the species, especially as the bulb is slight. Atkinson reports *M. mucor* from Blowing Rock (Journ. E. M. Sci. Soc. **9**: 99. 1892).

Illustrations: Cooke. Ills. Brit. Fungi, pl. 193A.
Gillet. Champignons, pl. 456 (153).
Sowerby. Engl. Fungi **3**: pl. 302.

Asheville. On old leaves.

Mycena capillaris Schum.

Cap minute, 1–3 mm. broad, campanulate to hemispherical, pale gray, becoming dead white when dry, glabrous, only slightly striate very thin and membranous.

Gills distant, white, narrow, adnate.

Stem 10–15 mm. long, capillary, glabrous, white.

Spores 4–5×8–10μ, ellipsoid. Cystidia broadly obovate to subglobose, thickly set with pointed projections. Basidia 4-spored.

This species seems not to have been reported from the United States before. It is almost our smallest species and can easily be overlooked. Our plant is certainly one of this group and seems distinct from *M. setosa*. I can find nothing inconsistent with its reference here.

Illustrations: Cooke. Ills. Brit. Fungi, pl. 193B.
Fries. Icon. Selectæ, pl. 84, fig. 6.
Gillet. Champignons, pl. 456, fig. 1.
Juillard-Hartmann. Icon. Champ. Sup., pl. 38, fig. 18.

Asheville. On old leaves.

Mycena pura Pers.

PLATES 8 AND 29

Cap 1–3 cm. broad, campanulate, becoming convex-expanded with the center somewhat prominent, lilac, rose-purple, pinkish or even white, moist, pellucid striate, glabrous; flesh thin, with a distinct taste and odor of radish.

PLATE 17

MYCENA GYPSEA. No. 2549

Photo by C

Gills colored like the cap but paler, rather broad, not crowded, connected behind by veins, adnate with a decurrent tooth.

Stem 3–10 cm. long, 2–5 mm. thick, colored like the cap but paler, smooth and shining, glabrous, white villous at the base.

Spores ellipsoid, 4–5×6–8μ. Cystidia abundant in a broad sterile zone at the margin of the gills and scattered on the sides, bluntly conical extending 20–35μ beyond the gills. Basidia 4-spored.

The large and abundant cystidia and the odor of radish are characteristic. I find one form which is pure white.

Coker's notes follow:

Cap 0.7–2.5 cm. broad, dry, smooth, rounded or plane, striate in most cases, often nearly to the center; margin very thin and eroded, color pale rose-purple or clear pink to pallid pink (said to be very variable at times lilac, grayish, pallid, yellowish, or white). Flesh with a distinct odor and taste of radishes.

Gills of various lengths, not close, attached by a decurrent tooth or some simply adnate, very deep and thin with edges eroded, light pink, connected by veins.

Stem 4–9 cm. long, 1–2.5 mm. thick, light pink, in some cases yellow at base or almost to top, hollow by a distinct channel, fragile.

Spores white, elliptic, with an oil-drop, about 4×7.4μ. Basidia 4-spored.

Easily distinguished by the taste and odor of radishes.

Illustrations: Atkinson. Stud. Am. Fungi, fig. 95.
Cooke. Ills. Brit. Fungi, pl. 157.
Gillet. Champignons, pls. 476 and 477.
Hard. Mushrooms, fig. 95.
Murrill. Mycologia **7**: pl. 158, fig. 3.
Ricken. Die Blatterpilze **2**: pl. 110, fig. 2.
Rolland. Atlas Champ., pl. 52, fig. 113.

56. On the ground and on a dead log in woods, Oct. 24, 1911.
7138. On the ground in mixed woods, Sept. 22, 1923.

Asheville. Solitary in old leaves, etc.

Blowing Rock. Atkinson.

Mycena lineata Bull.

PLATES 15 AND 29

Cap 5–10 mm. broad, grayish, with a distinct greenish tint, becoming whitish when dry, glabrous, striate nearly to the center, substance thin and membranous.

Gills at first white, in older specimens often with a greenish tint, not crowded, attenuate toward the stem and nearly free.

Stem whitish at the apex, darker below, slender, glabrous, attached at the base by white mycelial fibers to sticks and leaves.

Spores ellipsoid, 5×8–10μ. Cystidia 12–20μ broad, globose to rounded obovate, thickly set with small pointed warts. Basidia 4-spored.

Our plants are duller in color than Cooke's figure. They had, however, a distinct greenish color, though they became whitish as they lost moisture. Lange's figure shows our plants well. As is too often the case, there seems to be little agreement in Europe in regard to this species. Ricken has an altogether different plant from ours and Rea does not seem to agree entirely. Our plants seem to agree with Lange's notes and figure and are accordingly referred to *M. lineata* in the sense in which he has used it.

At all events, our plants represent a distinct and well-marked species, and it is hoped that the description and figure will aid in its recognition. As we understand the species, the most striking characters are the distinct greenish tint and the broad cystidia, with their densely set, small, wart-like processes. Many of our species have rounded cystidia with setulose processes. Usually, however, these processes are not numerous, only a few (3–6) being visible at one time on the periphery. In this species, as noted above, the cystidia are unusually large and the pointed processes are small and densely set, more like pointed warts than rods.

Illustrations: Cooke, Ills. Brit. Fungi, pl. 185B.
Fries. Icon. Selectæ, pl. 78, fig. 5.
Gillet. Champignons, pl. 470.
Lange. l. c., pl. 1, fig. i.

Asheville. On fallen sticks and leaves in woods.

Mycena minutula Pk.

PLATES 15 AND 29

Cap at first conic-campanulate, becoming expanded and somewhat umbonate, pure white, striatulate almost to the center, thin and membranous.

Gills pure white, broad, ventricose, sub-distant, mostly quadrate, adnate with a small decurrent tooth.

Stem white, slender, minutely downy with white hairs which become more conspicuous toward the base, attached at the base by white mycelioid fibers to the matrix.

PLATE 18

MYCENA GYPSEA (above)
MYCENA EXCISA (below)
Photos by B

Spores ellipsoid, 4×7.5–8.5μ. Basidia 4-spored. Cystidia blunt awl-shaped, extending about 20μ beyond the gills, 6–8μ thick.

While many collections of this little species will be found within the limits set by Murrill, it is to be noted that many forms are to be found considerably larger. During wet weather specimens are sometimes found with a yellow color which disappears as the plants dry. The species is quite abundant and at times will be found in quantity on old mossy logs.

3225. In moss on a white oak stump, Jan. 27, 1919.

Asheville. On rotten logs, old sticks, etc.

Mycena gypsea Fr.

PLATES 17, 18, AND 29

Cap 1–1.5 cm. broad, conic, becoming expanded and broadly campanulate, pure white, thin, even or only very faintly striatulate on the margin, glabrous.

Gills pure white, moderately close, narrow, about 1.5 mm. broad, and narrowest toward the margin, adnate with a decurrent tooth.

Stem 2–5 cm. long, 1–1.5 mm. thick, nearly glabrous but with a slight pruinose appearance under a lens, white strigose at the base.

Spores 4–5×7.5–9.5μ. Cystidia awl-shaped, extending 12–18μ beyond the margin of the gills, 4–6μ thick at the gill. Basidia not studied.

This species is frequently found in the summer at Asheville on old logs. Occasionally in wet weather the clumps will be partly colored yellow, but the color disappears with partial drying. Specimens and photographs were submitted to Bresadola some years ago and the determination approved. According to him, *M. lactea* is not cespitose, and *M. gypsea* is. Our plants were typically quite cespitose. We are following Bresadola in considering this plant *M. gypsea*.

Coker's notes follow:

Cap about 1–1.8 cm. broad (rarely as small as 3.5 mm.), convex, then irregularly expanded, sometimes remaining gibbous, sometimes depressed or slightly umbilicate, margin usually drooping and not striate or faintly so by pellucid lines; surface smooth, hygrophanous, not viscid, white or creamy white, all parts turning yellowish in drying. Flesh thin, rather rigid, taste slightly musty (hardly farinaceous), odor distinctly aromatic.

Gills rather distant, narrow, only 1.5 mm. wide, distinctly decurrent, white.

Stem 3–5 cm. long, about 1 mm. thick, equal, white, minutely

pruinose, solid, rather rigid and tough, hairy below and usually fused with others into clumps.

Spores (of No. 3549) white, elliptic, with one end pointed and curved, 3.7–5×7.4–10μ. Basidia (of No. 2549) 4-spored.

Easily recognized by the white color, aromatic fragrance, and cespitose stems bound together at the base by white hairs. All parts are rather firm and rigid. Beardslee reports this as growing on pine logs, but his plants are certainly the same as mine. According to Lange, the basidia of this species are 2-spored.

Illustrations: Cooke. Ills. Brit. Fungi, pl. 952A.
Gillet. Champignons, pl. 464.
Juillard-Hartmann. Icon. Champ. Sup., pl. 36, fig. 10.

2549. At base of a rotting oak stump, June 23, 1917.

2556. Around base of an oak stump, June 23, 1917.

2707. On rotting hardwood stump, July 19, 1917.

3549. In low place east of athletic field, Oct. 28, 1919. Entire plant pure white except for the creamy center of the cap.

Asheville. Cespitose on pine logs.

Mycena amabillissima (Pk.) Sacc.

PLATES 19 AND 29

Cap 0.5–1.5 cm. broad, campanulate when young, becoming expanded and nearly plane, with the center depressed, shell-pink to deep pink, paler at the center and fading with age, glabrous, not viscid, striatulate when moist; flesh-pink, thin, odorless.

Gills white or pinkish, narrow, not crowded, adnexed with a decurrent tooth.

Stem 1.5–3.5 cm. long, 1–1.5 mm. thick, slightly tapering downward, attached below with white mycelial fibers.

Spores 4–4.5×7.5–8.5μ, ellipsoid. Cystidia few, short, conical, smooth, free portion 4–8×10–15μ.

Unusual in its attractive pink color by which it is easily recognized.

Coker's notes follow:

Gregarious, cap 5–14 mm. broad, umbonate and hemispheric when young, plane and umbilicate at maturity, smooth, not viscid, striatulate when moist, deep pink, paler when dry. Flesh pink, rather brittle, 0.5 mm. thick, odorless and tasteless.

Gills moderately close, adnexed with a decurrent tooth, up to 1.3 mm. wide, light pink.

Stem 1.5–3.5 cm. long, 1–1.5 mm. thick above, tapering a little

PLATE 19

MYCENA AMABILLISSIMA. No. 2975

Photo by C

downward, glabrous, except the pruinose tip, base with loose white cotton, translucent, pinkish in upper half, the pink tending to fade out later; a minute hollow present.

Spores smooth, elliptic, 3.7–4×7.5–8.2μ. Cystidia conical, of various dimensions, some 14μ wide at base and extending about 15μ, others long and slender, about 6.8×30μ. Basidia 4-spored.

Easily recognized by the pretty reddish pink color which is not lost in drying.

2975. On a damp ditch-bank, mixed woods, Dec. 6, 1917.

Asheville. Gregarious on old leaves in wet places.

Mycena luteo-pallens Pk.

PLATES 20 AND 29

Cap at first rounded campanulate to hemispherical, becoming expanded and rounded convex to nearly plane, clear yellow to cadmium-orange when young, pale yellow-buff to almost white with age, dry, glabrous, striate to sulcate-striate.

Gills rather distant, alternating long and short, ventricose, pale yellow, adnate.

Stem pale yellow, smooth and shining, slightly pruinose at the apex, ending in a long, rooting portion which is covered with abundant white mycelium.

Spores rounded ellipsoid, 5–6×8–9μ. Cystidia abundant on the margin of the gills, broad and rounded, but ending in a short point, free portion 10–20×20–40μ. Basidia 4-spored.

The clear yellow of the young plant is characteristic. I find the long root invariably attached to the buried shell of some kind of nut.

Illustration: Murrill. Mycologia **7**: pl. 160, fig. 6.

Asheville. Solitary or cespitose on buried nuts.

Mycena Adonis Bull.

M. incarnata Pk.

M. pulcherrima Pk.

PLATES 16 AND 29

Cap 6–12 mm. broad, thin, conic-campanulate, becoming broadly campanulate with a pointed umbo, flesh-yellow, to pale reddish yellow on the margin, with the center darker and with a touch of carmine (close to apricot-buff [Ridgway] with the margin paler and the center

deeper and with more red), striatulate on the margin when moist, with a slight pruinose appearance under a lens.

Gills not crowded, whitish, or colored like the cap but paler, broadest at the center, attenuate toward the stem, adnexed.

Stem white, up to 4 cm. long, 1 mm. thick, delicately pruinose, becoming glabrous.

Spores ellipsoid, or ovate-ellipsoid, 5–6×7–8μ. Basidia 2-spored. Cystidia abundant rather long, blunt awl-shaped.

As we are interpreting it, this species is variable in color. The usual form at Asheville is yellow-flesh color with the center a more pronounced red. Farther north, and especially in Canada, forms with the same microscopic structure have been studied, which were much brighter and redder in color, the center of the caps being distinctly red. These forms seem to represent *M. subincarnata* and *M. pulcherrima*, but we have been unable to find any satisfactory basis of division, and are considering them and the North Carolina plant as only color forms of the same species.

The fact that, in its 2-spored basidia, the shape and dimensions of the spores, and the character of its cystidia, our plant corresponds exactly to *M. Adonis* (the red species of Europe), has led to the conviction that our plant is the American expression of that species. Material has been submitted to Lange, and an excellent water-color of *M. Adonis* as he finds it has been received from him. He points out that our plant seems to have a slightly longer stem, more conical cap, and less brilliant color than the plant he finds, but, in view of the close correspondence microscopically, says it may not be possible to separate the two.

His figure shows more brilliant color and more rounded cap than we have observed. Cooke's figure of *M. Adonis* shows a plant with the same conical cap, fully as long a stem, and the same range of color as our plant. Moreover, as is well known to those who have studied fungi in the field in both Europe and America, many species show considerable difference in color in their European and American forms. *Amanita muscaria*, for example, is much more brilliant in England and Sweden than in America. In view of these facts it has seemed best to consider our plant *Mycena Adonis* with *M. subincarnata* and *M. pulcherrima* as synonyms.

Some of our collections show considerable spore-variation. One collection has spores broader and rounder than is typical, so that they

PLATE 20

MYCENA LUTEO-PALLENS (above)
MYCENA EXCISA (below)

Photos by B

might be termed subglobose. These collections seemed typical in other points and have been considered merely forms.

Illustrations: Cooke. Ills. Brit. Fungi, pl. 185A.
Juillard-Hartmann. Icon. Champ. Sup., pl. 37, fig. 2.
Ricken. Die Blatterpilze **2**: pl. 109, fig. 6.

Asheville. In mosses on old logs, etc.

Mycena Iris Berk.
M. cyanobasis Pk.

PLATES 21, 22, AND 29

Cap 8–15 mm. broad, conic-campanulate to rounded campanulate, thin, slightly viscid when moist, pale gray with a greenish or bluish tint, paler toward the margin, which is adorned with closely glued-down fibrils which give it a distinct blue color, striate almost to the center, cuticle gelatinous, separable.

Gills white or nearly so, narrow, not crowded, narrowly adnate, white-fimbriate on the margin.

Stem 5–8 cm. long, about 1–2 mm. thick, grayish, paler at the apex, distinctly downy, extending 3–6 cm. in a crooked villous root, which is clothed with blue mycelial fibers.

Spores subglobose, 6–7.5μ broad. Cystidia extending about 20μ, the free portion narrowly cylindrical, 2–4μ thick, ventricose-inflated below. Basidia 4-spored.

On mossy logs, sticks, etc. Common.

The European form of this species seems to differ from the American only in its spores. Lange's figures for its spores are 3.5–4$\times$6.5–7.5μ; von Hohnel finds them about the same, though he finds one form which has spores more nearly like ours, 7–8$\times$8–10μ. Ricken says that *M. amicta* which, along with *M. marginella*, *calorhiza*, and *cærulescens*, he considers without doubt identical, has spores 4$\times$7–8μ. Bresadola describes his plants as having narrowly elliptical spores. The American plant uniformly has spores that are almost globose, 6–7.5μ broad.

Aside from the spores there seems little to separate *M. cyanobasis* from *M. Iris* and much to connect them. Ricken says that the best character of *M. Iris* is the shining, gelatinous, separable cuticle, which is also one of the best marks of our plant. Lange uses the fact that the stem is clothed with erect setulæ as an essential in his key. This is also true of the American plant. The English descriptions call attention to the striking blue fibrils of the cap. In typical specimens these are one of the most striking features of our plant. These fibrils are scattered

toward the center, giving it an elusive blue tint, while at the margin they are much more marked and are closely glued to the epidermis, making a beautiful blue line. The blue mycelium is also a link.

Coker's notes follow:

Cap up to 1 cm. broad, umbonate, bell-shaped or umbrella-shaped, striate to near the center, dull dark brown when young, the crimped margin lighter and distinctly tinted with light greenish blue and usually marked with fine collapsed fibers visible under a lens; at maturity a lighter but still strong ochraceous brown; in a form (as No. 3498) the cap color is clear bluish green all over, the center becoming brownish only after expansion.

Gills not crowded, ascending, whitish with a very faint tint of brown or pink, nearly free, about 1.5–2 mm. wide; margins set with long, slender, palisade-like cystidia, about 20–35μ long, which give the margins a frosty appearance under a lens.

Stem 4–5 cm. long or often longer by an extension among the leaves, about 1 mm. thick, hollow, pruinose all over, color of cap or nearly white, base and rooting part covered with fine fibers of the clear blue mycelium.

Spores (of No. 3061) white, smooth, subspherical, 4.8–6.3μ thick.

Illustrations: Cooke. Ills. Brit. Fungi, pl. 161 (lower figs.).
Peck. Rept. N. Y. St. Mus. **51**: pl. B, figs. 1–7 (as *M. cyanobasis*).

3061. In marshy ground covered with leaves, May 22, 1918.

3498. On leaf mold and rotting wood by deciduous log, Oct. 22, 1919.

3502. In damp low grounds, mixed woods, Oct. 25, 1919. Stem base with deep blue fibrils, but no blue fibrils on the cap and no blue tint in the brown cap color.

4423. In flat place by a branch, July 19, 1920. Spores subspherical, 5.5–7.4μ thick.

4536. On a decaying oak log, July 26, 1920. In some of these plants the entire stem turned bluish on drying.

7025. On an oak log, Aug. 1, 1923. Cap bluish green when young; base of stem deep blue-green.

Asheville. Common.

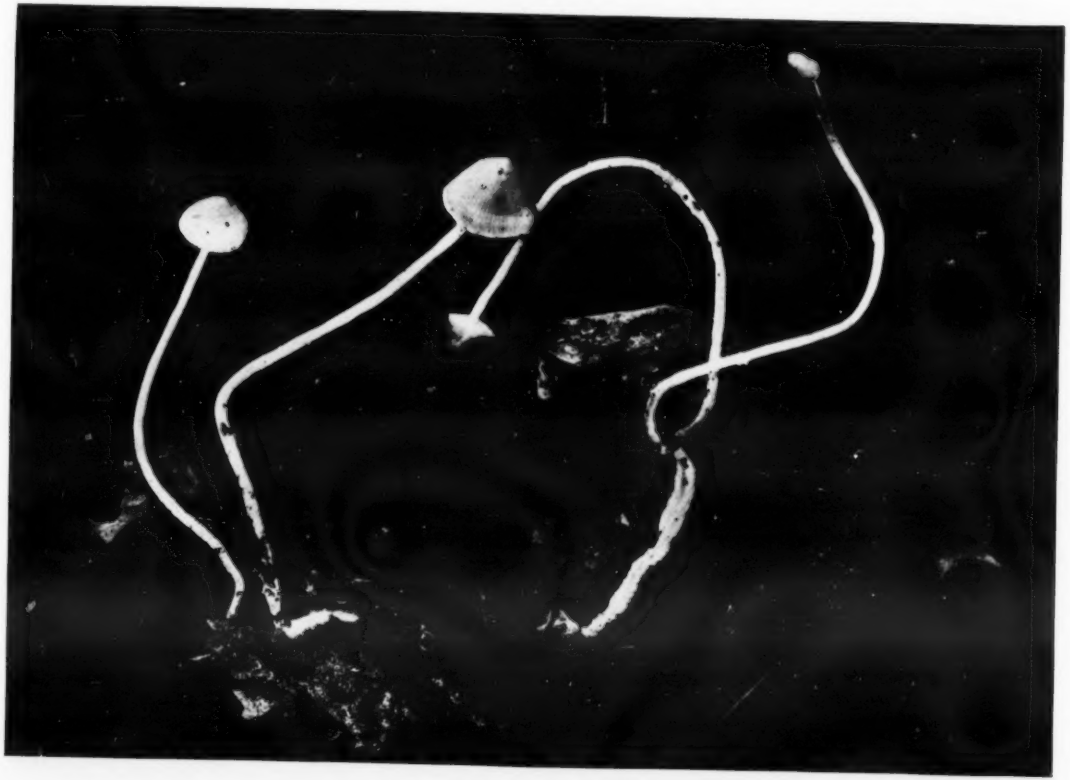
Mycena acicula Schaeff.

Cap 2–4 mm. broad, campanulate, becoming expanded and convex, often with a slight umbo, bright red, orange, or yellow with the center red, glabrous, striatulate on the margin.

Gills yellow to whitish, rather broad, ventricose, adnexed, somewhat distant.

Stem 2–5 cm. long, filiform, glabrous and shining, yellow or yellowish, rooting.

PLATE 21



MYCENA IRIS. No. 3498
Photo by C

PLATE 22

MYCENA IRIS (above and on right below)
MYCENA LEPTOCEPHALA (left below)

Photos by B

Spores narrowly ellipsoid, 2.5–3.5×7–9μ. Cystidia small, conical.

This little species may be known by its small size and bright color. I have found it rare in my collecting grounds, and have no notes of the basidia. They are said by Lange to be 4-spored.

Coker's notes follow:

Cap convex, about 4–5 mm. broad, thin, smooth, striate, color bright orange.

Gills distant, decurrent, connected by veins, about color of cap.

Stem slightly darker than the cap, about 4 cm. long, very slender, scarcely two-thirds of a millimeter thick, the lower part covered with long, yellow hairs.

Spores rod-elliptic, smooth, 3.7–4.5×6.6–7.5μ.

A very small plant but quite conspicuous on account of its bright orange-yellow color.

Illustrations: Atkinson. Stud. Amer. Fungi, fig. 98.
Cooke. Ills. Brit. Fungi, pl. 190C.
Fries. Icon. Selectæ, pl. 85, fig. 3.
Ricken. Die Blatterpilze **2**: pl. 109, fig. 7.
Sowerby. Engl. Fungi **3**: pl. 282.

129. In a damp place in mixed woods, Oct. 13, 1910.

Asheville. Rare in mixed woods.

Mycena atroalba Fr.

PLATE 14

Cap 10–15 mm. broad, narrowly campanulate, becoming expanded and round-campanulate with an acute, prominent, black umbo, grayish when moist almost white when dry with the exception of the black umbo, glabrous, sulcate-striate almost to the center, substance thin and almost membranous.

Gills white, rather narrow, adnate with a decurrent tooth, rather distant.

Stem 4–6 cm. long, 1–2 mm. thick, shining white above, fuscous toward the base, glabrous, attached to the matrix by abundant white mycelial fibers.

Spores 5–6×8–9μ. The cystidia and basidia were not studied.

This well-marked species seems to belong here. At Asheville it was found occasionally and was constant in its characters.

Illustrations: Juillard-Hartmann. Icon. Champ. Sup., pl. 35, fig. 4.
Ricken. Die Blatterpilze **2**: pl. 111, fig. 5.

Asheville. Occasional on old leaves.

Spores narrowly ellipsoid, 2.5–3.5×7–9μ. Cystidia small, conical.

This little species may be known by its small size and bright color. I have found it rare in my collecting grounds, and have no notes of the basidia. They are said by Lange to be 4-spored.

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Spores rod-elliptic, smooth, 3.7–4.5×6.6–7.5μ.

A very small plant but quite conspicuous on account of its bright orange-yellow color.

Illustrations: Atkinson. Stud. Amer. Fungi, fig. 98.
Cooke. Ills. Brit. Fungi, pl. 190C.
Fries. Icon. Selectæ, pl. 85, fig. 3.
Ricken. Die Blatterpilze **2**: pl. 109, fig. 7.
Sowerby. Engl. Fungi **3**: pl. 282.

129. In a damp place in mixed woods, Oct. 13, 1910.

Asheville. Rare in mixed woods.

Mycena atroalba Fr.

PLATE 14

Cap 10–15 mm. broad, narrowly campanulate, becoming expanded and round-campanulate with an acute, prominent, black umbo, grayish when moist almost white when dry with the exception of the black umbo, glabrous, sulcate-striate almost to the center, substance thin and almost membranous.

Gills white, rather narrow, adnate with a decurrent tooth, rather distant.

Stem 4–6 cm. long, 1–2 mm. thick, shining white above, fuscous toward the base, glabrous, attached to the matrix by abundant white mycelial fibers.

Spores 5–6×8–9μ. The cystidia and basidia were not studied.

This well-marked species seems to belong here. At Asheville it was found occasionally and was constant in its characters.

Illustrations: Juillard-Hartmann. Icon. Champ. Sup., pl. 35, fig. 4.
Ricken. Die Blatterpilze **2**: pl. 111, fig. 5.

Asheville. Occasional on old leaves.

Mycena debilis Fr.

PLATE 29

Cap 2–4 mm. broad, rounded campanulate, pale gray, becoming almost white, glabrous, sulcate-striate almost to the center, thin and membranous.

Gills close, white, rather narrow, adnate with a decurrent tooth.

Stem 3–6 cm. long, very slender and delicate, capillary, white, glabrous.

Spores lanceolate-ellipsoid, 5–6×11–14μ. Cystidia round-obovate with pointed projections.

This is a very small and delicate species. In appearance it is much like *M. filopes*, but it is much smaller and has distinctly larger spores. In some specimens the cap has a pinkish tint. It seems amply distinct from *M. filopes* and inasmuch as Lange makes *M. debilis* differ exactly as our plant does, I am referring it to this species.

Growing on the ground in old leaves and probably widely distributed.

Illustrations: Cooke. Ills. Brit. Fungi, pl. 189A.
Fries. Icon. Selectæ, pl. 82, fig. 4.
Gillet. Champignons, pl. 460.
Juillard-Hartmann. Icon. Champ. Sup., pl. 38, fig. 17.

Florida. New Smyrna.

Ohio. Painesville. On the ground in old leaves.

Mycena filopes Bull.

PLATES 23, 24, AND 29

Caps 4–10 mm. broad, campanulate with a slight umbo, gray at the center, paler and almost white at the margin, slightly striate when moist, glabrous, thin and delicate.

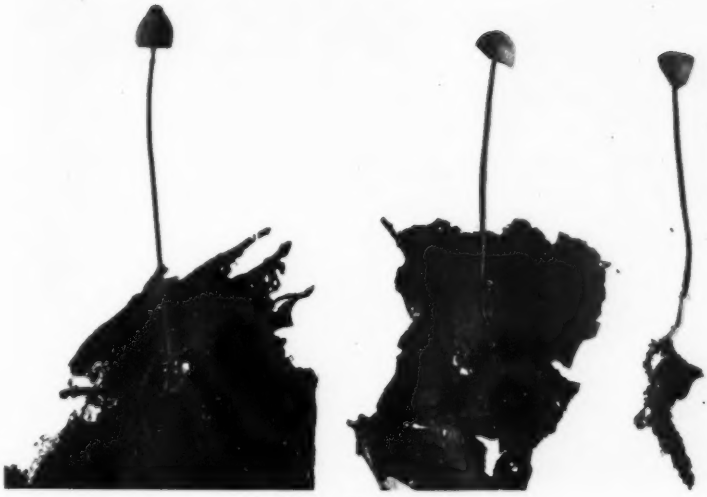
Gills close, narrow, white, attenuate-adnexed, margin usually slightly irregular.

Stem 4–10 cm. long, scarcely exceeding 1 mm. in thickness, glabrous, nearly white above, grayish toward the base, ending in a crooked, villous, rooting portion which is attached to old leaves or sticks.

Spores ovate, 5–6×8–10μ. Cystidia round-obovate, setulose. Basidia 2-spored.

Specimens and photographs of this species have been submitted to Prof. Lange who says in regard to them, "I can see no reason whatever why you should not call your little *Mycena, M. filopes.*" I have found it abundant at Asheville and in Ohio, and in scores of microscopic examinations have found the details of its structure quite constant. The

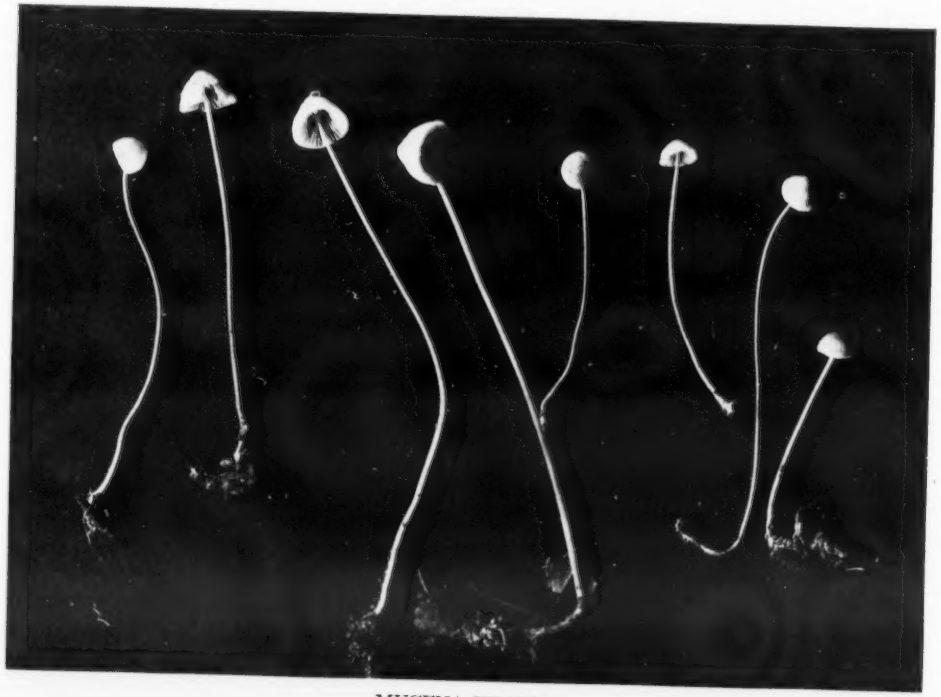
PLATE 23



MYCENA HIEMALIS (above)
MYCENA FILOPES (below)

Photos by B

PLATE 24



MYCENA FILOPES

Photo by B

basidia have been uniformly 2-spored and the cystidia always rounded with short, rod-like projections, which is exactly as they should be according to Lange. There seems little doubt that our species is *M. filopes* in the sense in which Lange defines it.

Ricken, however, identifies as this species a plant having smooth, spindle-shaped cystidia, which cannot be our plant. His description of *M. vitilis* agrees well with our plant, and is probably identical with it. At present no microscopic details of the American species which seem close to this are available save the spore measurements and it will be impossible to say which of them are referable here until more information is at hand. Dr. Murrill who has seen specimens and photographs of our plant says that it does not seem to be in his key to the genus and that he does not find it in his specimens.

As will be seen from our figures this species shows considerable variation in size. A small form with the cap 4–5 mm. is common. At times under favorable conditions, a larger form appears, having the same microscopic structure, and connected with the smaller form by an unbroken series. Lange considers this a form of *M. filopes*.

Illustrations: Cooke. Ills. Brit. Fungi, pl. 161 (upper figs.).
Juillard-Hartmann. Icon. Champ. Sup., pl. 36, fig. 3.

Asheville.

Ohio. Abundant.

Mycena inclinata Fr.

PLATES 25, 26, AND 30

Cap 1–3 cm. conic-campanulate, becoming expanded-campanulate or nearly plane, with the center somewhat prominent, brownish gray to pale gray, darker at the center, margin thin, at first incurved, and denticulate from the cuticle exceeding the gills, thin and membranous except at the center, striatulate when moist, becoming rugose-striate with age.

Gills thin, not crowded, white at first, at length with a slight tint of gray or flesh-color, adnate, slightly ventricose.

Stem at first white, becoming bright bay-brown with age, glabrous, often sulcate-striate with age.

Spores ellipsoid, 5–6×7.5–9μ. Basidia 4-spored. Cystidia difficult to demonstrate, rounded club-shaped, with a few setulose processes.

Lange considers this the same as *M. calopus* as Cooke figures it. Ricken would place *M. prolifera* with it also. Some of my specimens could easily be referred to *M. prolifera*. As I find it, no species forms such

dense clusters. In Florida it is abundant on oak stumps. The same is true in North Carolina. In Ohio it has been difficult to determine with certainty the character of the stumps and logs upon which it has been found.

Coker's notes follow:

Cespitose on rotten wood. Cap up to 3 cm. broad, umbonate, campanulate with incurved margin, then broadly campanulate, margin striate, irregular, often cracked; surface smooth, cinnamon-brown in center, drab-brown to buffy brown toward margin. Flesh very thin, hardly 1 mm. thick at stem edge, pliable; taste farinaceous; odor slight.

Gills not crowded, rounded at stem and adnate by a tooth, 3–5 mm. wide, thickish, veined at top, margin wavy, but not denticulate, whitish then flesh-color; at times with reddish stains.

Stem 3–4 cm. long, 3–4 mm. thick, equal, shining, smooth, pale tan, the base white-tomentose, stuffed then hollow, scarcely striate, the surface easily cracking.

Spores (of No. 2965) smooth, elliptic, 5–6.3×8–10μ. Basidia 4-spored; cystidia not found. Threads of gill trama 3–4.4μ thick.

The tightly packed bases often extend rather deeply into the wood. The species has much the appearance of a *Collybia*. See *M. intertexta* for a comparison with that species.

Illustrations: Cooke. Ills. Brit. Fungi, pl. 223 (as *M. galericulata* var. *calopus*).
Gillet. Champignons, pl. 465 (139).
Ricken. Die Blatterpilze **2**: pl. 111, fig. 3 (as *M. calopus*).
Juillard-Hartmann. Icon. Champ. Sup., pl. 35, fig. 10.

2965. On decaying log of frondose tree (probably oak), Dec. 3, 1917.

Asheville. In dense clusters on oak stumps and logs. Common.

Florida. Abundant on oak stumps.

Ohio. Abundant on stumps.

Mycena intertexta (B. & C.) Sacc.

PLATES 27 AND 30

The following description is by Coker:

Densely cespitose on rotting pine; cap 0.5–2.1 cm. broad, hemispheric or subexpanded, often somewhat umbonate, glabrous, not viscid, pallid tan or deeper cinereous brown, the center often darker; margin striate. Flesh thin, not very brittle; odor and taste slightly musty.

Gills subdistant, broadly adnate and mostly arcuate-decurrent by a tooth, pallid tan, in age yellowish brown.

PLATE 25

MYCENA INCLINATA. No. 2965
Photo by C

PLATE 26

MYCENA ALKALINA (upper left)
MYCENA FELLEA (upper right)
MYCENA INCLINATA (below)
Photos by B

Stem 2–8 cm. long, 1–1.5 mm. thick, glabrous, hollow, color of the cap and gills, the bases joined by dense, tawny floccose fibers which are very conspicuous where the stems run under the bark.

Spores (of No. 2955) smooth, elliptic, 4–5.5×6.8–8.6μ. Basidia (of No. 3601) 4-spored; hymenium 22–30μ thick; cystidia abundant on the gill margins and not rare on the sides, hyaline, pyriform, 11–15×22–30μ, often with 1 or 2 spines on the end. Threads of the gill trama 5–15μ thick, very irregular.

Not rare on rotting pine logs and stumps and appearing through worm-holes or from between the cracked bark, also on trash containing twigs and leaves of pine.

We have examined a bit of the co-type of *Ag. intertextus* from the Curtis Herbarium, through the kindness of Dr. Thaxter, and find our plants to be this species, as the description would indicate. The spores are the same shape and only slightly smaller than those of the Chapel Hill collections, a difference to be expected in material scraped from the long-exposed gills of the dried plants, most of them probably being immature. They are smooth, elliptic, 3.7–4.4×7.4–8.1μ; basidia 4-spored.

From Curtis' notes in the Curtis-Berkeley manuscript, a copy of which is to be found in the New York Botanical Garden, it would appear that he came to regard their *Ag. intertextus* as *Ag. cohærens*, although Curtis puts both in his list of North Carolina plants. Under his No. 1741 (*Ag. cohærens* A. & S.* *A. intertextus* B. & C.), Curtis says: "Cap carnose, membranaceous, hemispheric, 3–4 lines broad, strongly umbonate, striate, fuscous at the center, becoming paler toward the margin. Lam. unequal, white, thick, attached; stipe slender, smooth, fistulose, fuscescent above, paler and covered with villous below. Nov. Fasciculate in the worm-holes of a fallen pine, penetrating deeply among the carious wood. Vid. note at the end of next page."

This note is as follows:

"Note 1741. I have examined this after a rain and find the cap convex, slightly umbonate, 6–8 lines broad, lucid, fuscous cinereous, the margin pale and striate. Stipe lucid and rather fragile."

The species is near *M. inclinata*, but a careful study of our collections shows some differences corresponding to difference in habitat. *Mycena inclinata* grows on oak and possibly other frondose wood, the tomentum below is pure white in the dried state, and is more felted than filamentous, the threads of the gill trama are all very slender,

*Ag. cohærens is not an Albertini and Schweinitz species. It is now considered a *Marasmius* (see Kauffman, Agar. of Mich., p. 75).

3–4.4μ thick. *Mycena intertexta* grows on pine wood and trash, the tomentum is tawny and threadlike when dry, the threads of the gill trama are 5–15μ thick, averaging much thicker than in *M. inclinata*, and the cystidia are obvious.

It may be that *M. connatipes* B. & C., described as growing on the ground, is also the same, as its description will not separate it clearly, and Curtis does not list this in his catalogue of North Carolina plants, although he himself described it from North Carolina several years before his catalogue was printed.

2947. From decaying pine log in mixed woods. Nov. 20, 1917.

2955. On decaying pine log in woods, Dec. 1, 1917.

3521. On rotten pine wood mixed with frondose leaves, Oct. 25, 1919. Basidia 4.8–5.2μ thick, 4-spored.

3601. On mixed trash of pine and oak, Nov. 6, 1919.

Low district on decaying pine logs. Curtis.

South Carolina. Society Hill. (Curtis Herb.; co-type.)

Mycena galericulata Fr.

PLATES 28 AND 30

Cap 2–4 cm. broad, conic-campanulate, becoming expanded and flat campanulate with the center prominent, pale gray to dingy brownish gray, darker at the center, becoming deeply striate half-way to the center, glabrous, but with a dull, opaque appearance; odor weak, pleasant.

Gills broad, ventricose, not crowded, narrowed toward the stem to which they are adnate with a small decurrent tooth, white at first, becoming incarnate with age.

Stem 4–8 cm. long, 2–6 mm. thick, tough, colored like the center of the cap at the base, paler above, often with reddish stains, glabrous, shining.

Spores 5–6$\times$8–10μ. Cystidia pointed, rounded club-shaped, or obovate, setulose. Basidia 4-spored.

In clusters on old stumps.

It is peculiar that our common *Mycena* which has been universally considered *M. galericulata* should differ materially in its microscopic structure from the European plant. European students of this genus agree in ascribing to this species spores larger than are found in our American plant. Lange's figures are 6.5–8$\times$11–13μ; Ricken's 7–8$\times$ 9–11μ; and von Hohnel's 6.5–8$\times$10–12μ. Also all are in agreement in

PLATE 27

MYCENA INTERTEXTA. No. 2955

Photo by C

describing its basidia as 2-spored. Ricken says, "Microscopically this species is definitely identified by its narrow, 2-spored basidia," and all other authorities are in agreement with him. In scores of examinations of our American plant I have found no specimens with 2-spored basidia; all have been 4-spored. The cystidia of the American and European plants agree well, and in gross structure there is little or no discrepancy.

It has seemed wise to American authorities to ignore the differences and consider our plant the American expression of *M. galericulata*, differing in spores and basidia. For our treatment of a similar case, see under *M. iris*.

Coker's notes follow:

Plants strongly cespitose, toughish. Cap 1.2–3.5 cm. wide, conical, then campanulate and umbonate, distinctly striate over marginal half, margin constricted, extending into a pure white beautifully crenate-toothed membrane which may collapse and become indistinct; color light grayish brown or vinaceous brown toward margin, a much deeper vinaceous brown or umber brown in center. Flesh very thin, translucent, only 0.5 mm. thick near stem; taste and odor farinaceous and having to me also a slight taste of cucumber.

Gills not close, broadly attached, and descending a little way by a tooth, much broader at the marginal end where they are 3.5–4 mm. wide, white when young then faintly pinkish.

Stem about 7–13 cm. long and 2–3 mm. thick, tapering slightly upward, usually densely cespitose and attached to each other at base by the tomentum, very variable in color, usually white above and tinted like the cap below, but often yellowish or rosy or pale brown or even tawny, cartilaginous, hollow, smooth and shining except the basal part which is covered with conspicuous white, or brown or tawny tomentum.

Spores (of No. 1332) white, elliptic, smooth, 5.1–5.9×7.6–8.5μ. Basidia 4-spored.

Common on stumps and logs of frondose trees.

Illustrations: Cooke. Ills. Brit. Fungi, pl. 222.
Gillet. Champignons, pl. 462 (138).
Hard. Mushrooms, fig. 89.
Marshall. Mushroom Book, pl. 7.
Moffatt. Higher Fungi of the Chicago Region, pl. 4. 1909.
Murrill. Mycologia **10**: pl. 8, fig. 5. 1918.
Ricken. Die Blatterpilze **2**: pl. 111, fig. 1.
Rolland. Atlas Champ., pl. 51, fig. 112.

57. On a rotten stump, Oct. 20, 1911.

1332. In clusters on base of a rotting stump, Oct. 13, 1914. Vinaceous buff on marginal half and umbo, lighter between.

1906. On a rotting oak stump, Oct. 18, 1915. Spores white, smooth, subspherical to short-elliptic, 5.5–7.2×7.2–9μ.

2501. On a very rotten oak log, May 10, 1917.

3057. On decaying log in low grounds, May 22, 1918.

Asheville. Common.

Blowing Rock. Atkinson.

Linville Falls. No. 5771. On decayed chestnut wood, Aug. 24, 1922. (Coker.)

Mycena polygramma Fr.

PLATE 30

Cap thin, 1.5–2.5 cm. broad, campanulate, with the upper portion narrow conical, and the lower portion flaring and expanded, gray with the center darker, becoming rugose-striate nearly to the center with age, glabrous. No odor.

Gills white, becoming pinkish, attenuate behind, subdistant, uncinate.

Stem 7–10 cm. long, 2–3 mm. thick, equal, tense and straight, pale above, cinereous fuscous toward the base, longitudinally striate, strigose-rooted at the base.

Spores broadly ellipsoid, 5–6×7–8μ. Cystidia with a narrow awl-shaped apex, swollen inflated at the base. Basidia 4-spored.

This fine and well marked species has been found only in the North, and has been referred somewhat doubtfully as above, many of its characters being well covered in the European descriptions of *M. polygramma*. Its gills are rather unusual, broad toward the margin of the cap and much attenuate toward the stem, to which they are attached with a slight tooth. The margin in my specimens was usually serrulate and the color in old specimens was pink. The stem was unusually long and beautifully longitudinally striate. The spores were unusually broad, and the cystidia while inflated below extend in a slender free portion. All this accords well with Rea's description, and with such data as Lange gives. Both Ricken and Lange make the striations of the stem, which are conspicuous in our plants, important. Ricken describes color forms which our plants did not have, but otherwise his description fits our plant well. Our plant is certainly a well-marked species and is close to *M. polygramma*, to which a reluctance to describe new species impels me to refer it.

PLATE 28

MYCENA GALERICULATA. No. 1906

Photo by C

Illustrations: Cooke. Ills. Brit. Fungi, pl. 223.
Juillard-Hartmann. Icon. Champ. Sup., pl. 36, fig. 1.
Ricken. Die Blatterpilze 2: pl. 111, fig. 7.

Ontario: Magnetawan. Solitary on sticks and rubbish in woods.

Mycena excisa Fr.

PLATES 18, 20, AND 30

Cap 1–3 cm. broad, broadly campanulate, becoming expanded and plano-convex, with a small umbo, sooty brown, moist or subviscid, rather thin, glabrous, slightly striate on the margin. Odor slight, pleasant.

Gills not crowded, white, broadest at the center, narrowed behind so as to appear almost free.

Stem 2–4 cm. long, white or colored like the cap but paler, minutely downy, with abundant white, mycelial fibers at the base.

Spores broadly ellipsoid, 6–7×8–9μ. Cystidia abundant, large, the free portion cylindrical, extending 50–60μ beyond the gills. Basidia 4-spored.

Although this seems one of the most distinct species of this group, it cannot be placed with certainty at present. It is marked by its broadly expanded and nearly plane cap, its dark color, its distant and nearly free gills, downy stem, large cylindrical cystidia, and broadly rounded spores. These characters are all included in Lange's description of a plant referred with some doubt to this species, his drawings of the cystidia and spores exactly representing those of our plants, which are like nothing else in this particular. It has seemed best on this account to consider our plants *M. excisa* in the sense in which he defines it.

As is too often the case, European authorities are far from agreement on this species, and our plants cannot be definitely disposed of until some of this confusion is cleared up. Cooke's figure of this species is clearly entirely different. Fries represents it fairly well.

Illustrations: Fries. Icones, pl. 81, fig. 1.
Juillard-Hartmann. Icon. Champ. Sup., pl. 34, fig. 4.

Asheville. On old logs.

Ohio: Painesville.

Mycena fellea Lange.

PLATES 26 AND 30

"Cap conic-campanulate, 7–11 mm. broad, slightly striate, and with a faint bloom, dull gray.

"Gills rather narrow, neither crowded nor distant, narrowed behind and somewhat adnate.

"Stem 3–4 cm. long, 1 mm. thick, smooth, color of the pileus. The whole plant has a pronounced acrid taste like gall or quinine.

"Spores sub-rotund, oval, 7–8 x 9–11μ. Cystidia variable, sometimes fusiform, pointed, sometimes obtuse, with the apex set with a number of setiform branchlets. Basidia 4-spored."

Lange's description of his species as quoted above applies well to a plant which seems not rare in Ohio. Our specimens were dull gray, usually, however, of a brownish gray, which soon enables the collector to distinguish it. The gills in my specimens were narrow and adnate but were also distinctly distant, rather than medium, as Lange describes them. The two unusual characters are the taste and the cystidia. The taste is a surprise. It is as persistently bitter as quinine, and only one of the small caps produces a lasting effect. The cystidia are found in two forms: One form is large and fusiform with a sharp point. These are the more abundant, and occur on the sides as well as the margins of the gills. In addition to these are found rounded club-shaped cystidia with setiform projections. I have seen no other species of which this is true. The spores of our plants are a little smaller than Lange finds them, being 5–6×7–9μ. Our plants seem so close to Lange's description that it has been thought best to refer them to it.

Illustration: Lange. l.c., pl. 1, fig. f.

Ohio: Painesville. On bark of an old stump and on old leaves.

Mycena alkalina Fr. PLATES 26 AND 30

Cap 1–3 cm. broad, at first narrowly campanulate, then expanded campanulate, hygrophanous, dark brownish gray to pale gray when moist, pale gray, usually with the center darker when dry, glabrous, deeply striate when moist, substance thin except at the center.

Gills white to cinereous, 4–5 mm. broad at the center, narrowed toward the ends, adnate with a decurrent tooth.

Stem 5–7 cm. long, 2–4 mm. thick, slippery when moist, shining when dry, white or pale gray, rigid but rather fragile, glabrous above, white villous at the base.

Spores ellipsoid, 5–6.5×8–10.5μ. Cystidia 9–10μ thick at the margin of the gills, extending as much as 70μ to a narrow acuminate point above, occurring on the sides as well as the margins of the gills. Basidia 4-spored.

Illustrations: Cooke. Ills. Brit. Fungi, pl. 225.
Fries. Icon. Selectæ, pl. 81, fig. 3.
Juillard-Hartmann. Icon. Champ. Sup., pl. 34, fig. 15.

3536. On a pine log, Oct. 28, 1919. A small form with the cystidia shorter than usual, but apparently this species.

Asheville. Cespitose on logs and stumps.

Ohio: Painesville. Cespitose on old logs and stumps, July 14, 1923.

Mycena leptocephala Pers.

PLATES 22 AND 30

Caps campanulate, 1–1.5 cm. broad, cinereous to pale ashy gray, with a canescent appearance, at times minutely pruinose, deeply sulcate-striate nearly to the center, margin thin and membranous. Odor slight, alkaline.

Gills white, becoming grayish, rather narrow, broadest at the middle, adnate with a slight decurrent tooth, rather distant.

Stem up to 6 cm. long, about 1 mm. thick, colored like the cap, glabrous above with white mycelial fibers at the base.

Spores ellipsoid, 6–7×8–10μ. Cystidia abundant on the margins of the gills, not detected on the sides, conic, awl-shaped, usually sharp pointed, inflated below, extending about 20μ, 8–12μ thick at the gill. Basidia 4-spored.

I am placing here a series of specimens whose distinguishing characteristics are the ashy gray and somewhat canescent caps, with deeply sulcate striations and the weak alkaline odor. In one collection the cystidia were strongly ventricose inflated below.

Illustrations: Cooke. Ills. Brit. Fungi, pl. 187A.
Gillet. Champignons, pl. 469.
Juillard-Hartmann. Icon. Champ. Sup., pl. 35, fig. 12.

3578. In moss on a decaying pine log, New Hope Creek swamp, Nov. 1, 1919.

Asheville. On fallen sticks and mossy logs, solitary.

Mycena ammoniaca Fr.

PLATE 30

Cap 0.5–1.5 cm. broad, conic-campanulate, becoming expanded and obtusely umbonate, dark grayish brown to grayish umber, paler when dry, hygrophanous, striatulate on the margin which is thin and membranous, glabrous.

Gills white to cinereous, moderately close, broadest at the middle, emarginate-adnate.

Stem 4–6 cm. long, 2–4 mm. thick, colored like the cap but paler above, glabrous above, the rooting portion white villous.

Spores 5–6×7.5–9μ, ellipsoid. Cystidia conic awl-shaped to bottle-shaped, 7–12μ thick at the margin of the gills, extending 20–30μ. Basidia 4-spored.

The odor of this species seemed variable. It is always alkaline, but occasional specimens were found in which it was especially strong. Others had rather a weak odor.

Illustrations: Cooke. Ills. Brit. Fungi, pl. 238A.
Juillard-Hartmann. Icon. Champ. Sup., pl. 36, fig. 8.

Ontario: Magnetawan. On the ground among fallen leaves.

EXPLANATION OF PLATES

Spores and cystidia of most of the species listed are shown in the following plates as indicated below. In *M. anomala* a section of the cap showing the attachment of the gills is also shown, and in *M. tenerrima* the large spinulose cells on the surface of the cap and the rough hairs of the stem. Plate 29 and pl. 30, figs. 1–8 by Beardslee; pl. 30, figs. 9–16 by Miss Alma Holland and Mr. J. N. Couch.

PLATE 29

Mycena erubescens. Fig. 1.
Mycena galopus. Fig. 2.
Mycena hæmatopa. Fig. 3.
Mycena sanguinolenta. Fig. 4.
Mycena anomala. Fig. 5.
Mycena Leajana. Fig. 6.
Mycena pelianthina. Fig. 7.
Mycena rubromarginata. Fig. 8.
Mycena capillaripes. Fig. 9.
Mycena stylobates. Fig. 10.
Mycena tenerrima. Figs. 11 and 12.
Mycena corticola. Fig. 13.
Mycena hiemalis. Fig. 14.
Mycena setosa. Fig. 15.
Mycena pura. Fig. 16.
Mycena lineata. Fig. 17.
Mycena minutula. Fig. 18.
Mycena gypsea. Fig. 19.
Mycena amabillissima. Fig. 20.
Mycena luteo-pallens. Fig. 21.

PLATE 29

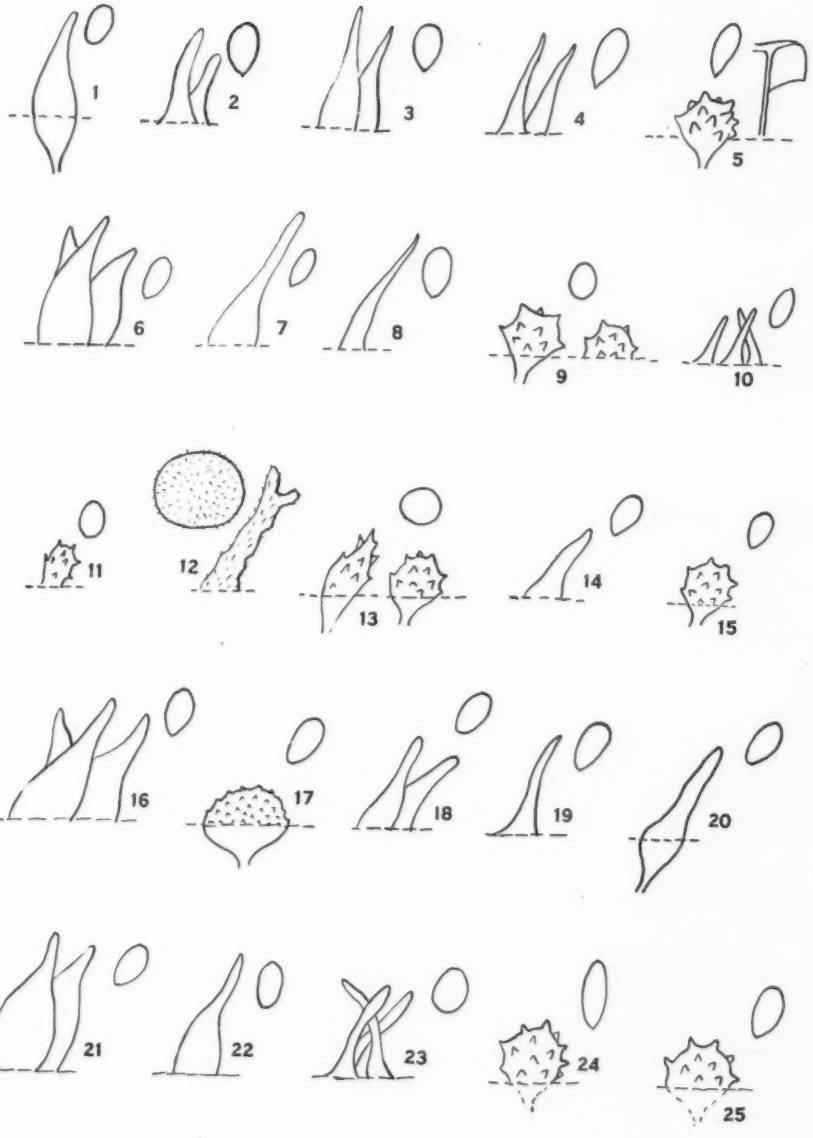
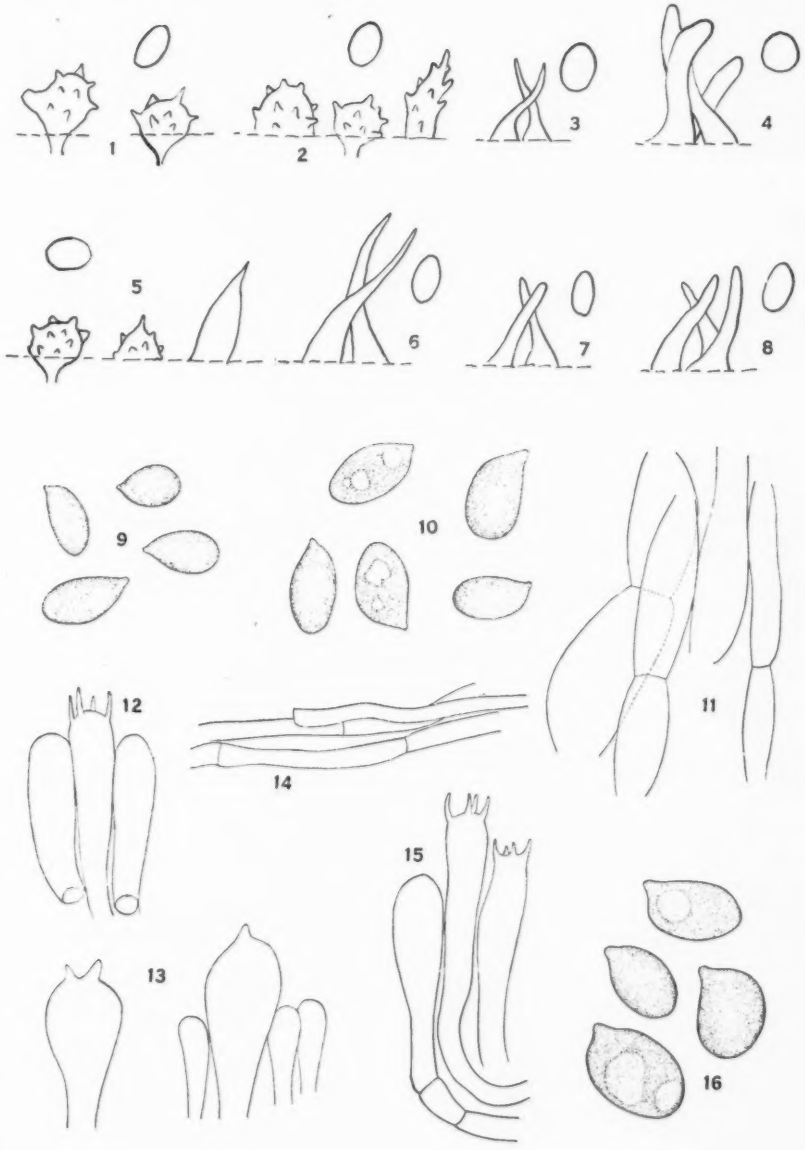


PLATE 30



Mycena Adonis. Fig. 22.

Mycena Iris. Fig. 23.

Mycena debilis. Fig. 24.

Mycena filopes. Fig. 25.

All figures ×750.

PLATE 30

Mycena inclinata. Fig. 1.

Mycena galericulata. Fig. 2.

Mycena polygramma. Fig. 3.

Mycena excisa. Fig. 4.

Mycena fellea. Fig. 5.

Mycena alkalina. Fig. 6.

Mycena leptocephala. Fig. 7.

Mycena ammoniaca. Fig. 8.

Mycena intertextus. Co-type, fig. 9; No. 2955, fig. 10; No. 3521, fig. 11 (threads of gill trama) and fig. 12; No. 3601, fig. 13 (hymenium and cystidia).

Mycena inclinata. No. 2965, fig. 14 (threads of gill trama) and figs. 15 and 16. Figs. 1–8×750; figs. 9, 10, 16×1620; fig. 13×810; figs. 11, 12, 14, 15×1012.

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